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DEVELOPMENT OF THE B31.8 CODE AND FEDERAL PIPELINE SAFETY REGULATIONS: IMPLICATIONS FOR TODAY'S NATURAL GAS PIPELINE SYSTEM

VOLUME I: TECHNICAL REPORT

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13. ABSTRACT (Maximum 200 words)

This report documents the intentions and founding principles of the ASME B31.8 Gas Transmission and Distribution Piping Systems Codes and the Pipeline Safety Regulations (Title 49 Code of Federal Regulations Part 192). Two meetings were held with distinguished pipeline experts and the first directors of the Office of Pipeline Safety to provide background information on the development of the Codes and Regulations. The focus of this effort was natural gas transmission pipeline operations. This report also addresses five major topics of interest to the U.S. transmission pipeline industry: establishing the threshold for operating pressure, class location areas, valve spacing, inspection frequencies, and public communications. Through an understanding of the Code and regulatory foundations, the pipeline industry can more effectively interpret and apply the requirements and recommendations to today's natural gas pipelines. In addition, the industry can use this information to support continued public benefit, improved safety, and industry growth.

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RESEARCH SUMMARY

Title	Development of the B31.8 Code and Federal Pipeline Safety Regulations: Implications for Today's Natural Gas Pipeline System
Contractor	Radian International GRI Contract No. 6032
Principal Investigator	Theresa M. Shires and Matthew R. Harrison
Report Period	June 1998 through December 1998
Objective	To document the early development of the ASME B31.8 Code and federal Pipeline Safety Regulations so that current and future pipeline engineers can understand the basis of these industry standards and regulatory requirements.
Technical Perspective	The B31.8 pipeline industry Code and the Title 49 CFR Part 192 regulatory requirements have evolved over time based on technological developments and engineering advances, as well as political and operational philosophies. Current pipeline Code and Regulations differ significantly from the original documents. An understanding of the Code and regulatory foundations is necessary to interpret and apply these requirements to today's natural gas pipeline systems in the interest of safer and more efficient pipelines.
Technical Approach	Two meetings were held with a number of distinguished pipeline experts to discuss the development of the original B31.8 gas pipeline Code. In addition, the first directors of the Office of Pipeline Safety joined in this effort to provide background on the federal Pipeline Safety Regulations. The focus of this effort was natural gas transmission pipeline design, construction, and operations. Discussions covered the founding principles of the B31.8 Code and the federal Regulations and addressed the following five major topics of interest to the pipeline industry: 1) establishing the bases for operating pressure; 2) class location areas; 3) valve spacing; 4) inspection frequencies; and 5) public communications.
Results	This report presents a compilation of information and discussions with founders of the B31.8 Code and federal Pipeline Safety Regulations. The two group meetings were video taped for archival purposes.
Project Implications	The results of this study provide the natural gas industry with a greater understanding of the founding principles and intentions of the B31.8 Code and federal Pipeline Safety Regulations. Industry can use this information to support continued public benefit, improved safety, and industry growth. GRI Project Manager Dr. Keith Leewis Transmission Business Unit

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1.0 Introduction

1.1 GRI Initiative

Although the Code may appear to be explicit, the interpretation of the Code, particularly that which is incorporated into Title 49 of the Code of Federal Regulations Part 192 (49 CFR Part 192), is not as clear-cut. The Code documents standards that were developed from years of operating experience and empirical data. The Code is the fruit of a significant work commitment by engineers to reduce complexities into simple practice. Prior studies by Mr. Bob Eiber and Mr. Wes McGehee examined the intent of the regulatory requirements (McGehee, 1998; Eiber, 1997), but these documents are not publicly available and contained topics where cited reference information could not be located.

The Gas Research Institute (GRI) sponsored an initiative to prepare a summary of the development of the original American Society of Mechanical Engineers (ASME) B31.8 Gas Transmission and Distribution Piping Systems Code. The 1968 edition of the Code was used by the Office of Pipeline Safety (OPS) as a basis for issuing the federal Pipeline Safety Regulations as embodied by 49 CFR Part 192. The purpose of this initiative was to document the early Code and regulatory developments so that current and future pipeline engineers can understand the basis and logic used in establishing the requirements. To meet this objective, retired pipeline experts and the first two directors of OPS joined in this effort to provide information.

1.2 Participants

Through two meetings, some of the founders of the B31.8 Code and 49 CFR Part 192 gathered to recall and describe the Code and regulatory development. Appendix A lists pipeline *emeritus*, former OPS staff, and others who participated.

1.3 Report Structure

In comparing the current (1995 Edition)[1] B31.8 Code to the 1955 version, many significant revisions and/or additions have been made over the years. These include:

- Requirements for the transportation of pipe;
- Provisions for the reuse of pipe;
- Provisions for fracture control and arrest;
- Provisions for brittle fracture control;
- Design and testing requirements to allow operation of pipeline up to 80 percent of SMYS;
- Replacement of the "type construction" concept with design factors for class location;
- Provisions for plastic pipe;
- Requirements for written emergency procedures;
- Liaison with public, fire, police, and other public officials;
- Requirements for education programs;
- Chapter on corrosion control;
- Chapter on offshore pipelines;
- Fabrication details (new appendix);
- Criteria for cathodic protection (new appendix);

[1] The 1998/99 version is being finalized.

- Development of a Supplemental Standard (ASME B31G *Manual for Determining the Remaining Strength of Corroded Pipelines)*;
- Gas leakage control criteria (new appendix); and
- Recommended practice for hydrostatic testing of pipelines in place (new appendix).

This document addresses the development of the B31.8 Code (Section 2) and the foundations of the Pipeline Safety Regulations (Section 3). Although the Code and Regulations were developed for application to gathering, transmission, and distribution pipelines, the focus of this analysis is on natural gas transmission pipeline design, construction, and operations.

In addition, this document addresses five major topics of interest to the pipeline industry:

1. Maximum Allowable Operating Pressure (MAOP) (Section 4);
2. Class Location (Section 5);
3. Valve Spacing (Section 6);
4. Inspection Frequency (Section 7); and
5. Public Communication/Education (Section 8).

Conclusions are presented in Section 9, and Section 10 provides references. The appendices provide a list of meeting participants, a list of the 1955 B31.1.8 committee members, and reprints of some founding documents from the development of the Pipeline Safety. The appendices also include the draft final report *Maximum Allowable Operating Pressure (MAOP) Background and History* (McGehee, 1998), which led to the resolve to initiate this report.

The meeting proceedings were videotaped to aid in documenting the discussions. A single copy is archived in GRI's library. The set includes:

B31.8 Discussion
June 25, 1998
Volume 1: Overview and Introductions
Topic 1: Establishing MAOP
57:00 minutes

Volume 2: Topic 2: Class Location Areas
Topic 3: Valve Spacing
Topic 4: Inspection Frequencies
Topic 5: Public Education
114:32 minutes

Transition of B31.8 to 49 CFR 192
August 20, 1998
Volume 1: Topic 1: Review of June Meeting
Topic 2: Discussion on 49 CFR Part 192
144:30 minutes
Volume 2: Topic 3: Gas Piping Technology Committee
Topic 4: Current Industry Issue
45:40 minutes

In addition, Volume 2 of this report provides a transcription of the meeting discussions.

2.0 History of B31.8

2.1 Background

The private development of material standards and performance codes preceded governmental regulations of this nature by several decades. For the pipeline industry, the need for a national pressure piping code became increasingly evident from 1915 to 1925. In March of 1926, the American Standards Committee (later changed to the American Standards Association and currently the American National Standards Institute) initiated Project B31 at the request of the American Society of Mechanical Engineers. After several years work by Sectional Committee B31 and its subcommittees, the first edition of the Code was published in 1935 as an American Tentative Standard Code for Pressure Piping. It covered pressurized piping for power, gas, air, oil and district heating. Following incorporation of refrigeration in the scope, it was published in 1942 as the American Standard Code for Pressure Piping. Additions and/or supplements to this Code were published in 1944, 1947, and 1951.

Another factor in the development of pipeline Code was congressional interest in pipeline safety in the early 1950's. As a result of 1947 eminent domain legislation and two relatively obscure pipeline incidents in 1950, Congress began to focus on the issue of pipeline safety. Representative John W. Heselton of Massachusetts introduced a bill in the 81st Congress seeking to establish federal regulations covering natural gas pipelines (Congressional Research Service, 1986). This bill provided an impetus to the industry to develop its own safety code in order to forestall the need for congressional action.

2.2 B31.8

At its annual meeting on November 29, 1951, the B31 Standards Committee authorized subdividing the Code and issuing a separate publication of a natural gas section for gas transmission and distribution piping systems. The purpose was to provide an integrated document for gas transmission and distribution piping that would not require cross referencing other sections of the Code (ASME, 1995). The stand-alone gas Code was issued in 1952 as ASA B31.1.8: *American Standard Code for Pressure Piping, Section 8, Gas Transmission and Distribution Piping Systems*. It consisted almost entirely of material taken directly from Section 2 (Gas and Air Piping), Section 6 (Fabrication Details) and Section 7 (Materials) of the 1951 Edition of the Pressure Piping Code.

Later in 1952, a completely new B31.1.8 Committee was formed to update the Section 8 Code so that it more adequately covered all aspects of pipelining. This update incorporated new materials and new design, construction, and testing methods that were rapidly being developed. The new Committee was chaired by Mr. Fred Hough, Vice President of Southern Counties Gas Company in Los Angeles. The Committee consisted of representatives from transmission and distribution companies, the public through the participation of the Federal Energy Regulatory Commission (FERC) and state utility commissioners, pipe and equipment manufacturing companies, and other technical experts.

The Committee's first meeting was held in Chicago in 1952. The Committee organized itself into a number of subgroups, each responsible for preparing a particular section of the Code. There were many meetings held over time, with 125 to 130 attending members and support people. Over a period of two and a half years, as preparation of the new Code material proceeded, many diverse opinions were expressed and many parts of the Code received extensive argument and discussion before final agreement. This discourse, plus input from a number of research programs, contributed to producing a realistic Code that represented generally accepted and safe practices. The new Code document was published in 1955 as ASA B31.1.8 Gas Transmission and Distribution Piping Systems.

The intent was for the Code to be a compendium of good design, construction, operation, and maintenance practices. The industry's objective was to make a major contribution to the improvement of public safety by understanding the causes of failures and establishing guidance, procedures, and methods for reducing pipeline failures. As a secondary objective, the Code was developed with the intent that, if necessary, it could be adopted by reference into a regulatory framework (Hough, 1954).

A series of articles written by Mr. Fred Hough and published in *GAS* magazine starting in November, 1954, provide insight into the intentions and reasoning of the Committee in preparing the Code. Some excerpts from these articles follow (Hough, 1955).

- "The requirements of Section 8 are adequate for safety under conditions normally encountered in the gas industry. Requirements for abnormal or unusual conditions are not specifically provided for, nor are all details of engineering and construction prescribed. It is intended that all work performed within the scope of this Section shall meet or exceed the safety standards expressed or implied within."

- Since the Code states what is generally accepted as good practice, it does not include good practices that are not generally accepted. As a result, "superior practices, which under some conditions at least are highly desirable, are not prescribed in the Code."

- The Code was not written to be used as a specification. "A specification is intended to fully describe a material or piece of equipment and to specify the tests and tolerances to be applied to determine whether a given sample fits the description accurately." Rather, the Code prescribes conditions of use to which items complying with standard specifications can be applied.

In 1958, further revisions were published as ASA B31.8 - 1958.

The strength of the original Code is reflected in the fact that B31.8 was adopted by all of the state agencies that had authority to regulate gas pipeline safety and also was adopted by many countries throughout the world. The B31.8 Code has also contributed to the worldwide growth of the pipeline industry by providing standards that, when followed, result in an acceptable level of safety.

As each generation of the Code Committee brings new ideas and advances in technology, the industry Code has continued to evolve to reflect changes in practices, solutions to emerging safety problems, and new technologies.

2.3 The Pipeline Research Committee

The Pipeline Research Committee (PRC) has played an important role in the development of the B31.8 Code provisions. PRC was formed in 1952 at the suggestion of the B31.1.8 Code Committee to pool industry research funds to address the issue of long running brittle fractures. The results of this initial effort were well received by the industry, and the PRC continued to pursue other cooperative research needs funded by the pipeline industry under agreement with the American Gas Association (A.G.A.).

The mission of the PRC*I*[2] is to sponsor and direct basic and applied research aimed at optimizing all technical aspects of the natural gas transmission industry and its related activities. In an effort to direct a concentrated research program, PRC*I* operates under the following objectives:

[2] In 1996, the PRC adopted the name Pipeline Research Committee *International* (PRC*I*) to better reflect its current membership, which consists of about 15 major U.S. natural gas companies and 15 international members.

1. Provide for the definition and systematic resolution of all major technical problems faced by industry;
2. Promote the development of new ideas, methods, procedures, and equipment to improve existing design and construction practices, and the continued safe operation of existing and future pipeline facilities;
3. Sponsor training, seminars, and symposiums, and prepare technical reports to inform industry operators, technicians, and engineers on current and pertinent research results; and
4. Encourage meaningful additions to governing codes, regulations, and specifications in the interest of safer and more efficient pipelines.

PRC*I* has funded a wide variety of research efforts aimed at these objectives. Some of the research efforts include:

- Underbed cracking during welding;
- Welded branch connection design;
- Secondary stresses in pipelines;
- Brittle fracture control and prevention;
- Cyclic stresses during rail shipment of pipe;
- High-pressure hydrostatic testing;
- Hydrogen cracking;
- Stress corrosion cracking;
- Ductile fracture arrest;
- Fracture initiation;
- Definition of defect severity;
- Defect repair methods;
- Strength of corroded areas;
- Inline inspection methods;
- Surveys of causes of service failures;
- Failure investigations; and
- Symposia to disseminate research results to industry.

These research efforts vary from small, short duration projects to large, multi-year programs. The results of many of the programs were used directly in preparing Code material. The results from a few programs led to specifications or recommended practices published in other documents and referenced in the Code.

3.0 Pipeline Safety Regulations

One of President John F. Kennedy's campaign promises in the 1960 election was a broad commitment to consumer safety (Congressional Research Service, 1986). The interest of the federal government in consumer protection was not new, but the 1960's brought about a recognition of the consumer's "right to safety." President Lyndon B. Johnson reiterated the consumer interest message in 1964 and specifically called attention to pipeline safety in his 1967 State of the Union Address:

> "We should immediately take steps to prevent massive power failures, to safeguard the home against hazardous household products and to assure safety in the pipelines that carry natural gas across our Nation..." (Congressional Research Service, 1986).

The Natural Gas Pipeline Safety Act, enacted on August 12, 1968, established exclusive federal authority for safety regulation of interstate transmission lines. It also established non-exclusive federal authority for safety regulation of gathering lines in non-rural areas and intrastate transmission and distribution pipelines (Docket OPS-3, 1970). It did not include gas production or related processing facilities.

The Pipeline Safety Act gave the Secretary of Transportation broad powers to develop and publish federal standards applicable to the design, construction, operation, and maintenance of facilities used in the transportation of natural (and other) gas. It also required the Secretary of Transportation to adopt, within three months, interim regulations, and within 24 months to establish minimum federal safety standards. The regulations were to establish minimum safety standards for all phases of the design, construction, maintenance, and operation of gas pipeline facilities.

The Office of Pipeline Safety (OPS) was formed to administer the Pipeline Safety Act and to serve as a clearinghouse for safety information. A role assigned to OPS was to investigate system failures, research the causes of failures, define safety problems, and seek solutions to those problems. Prior to this, there were no reporting requirements for gas pipeline accidents. A study was initiated in 1968 to begin gathering pipeline incident data and to develop the first incident reporting form. This study established a data management system and incident reporting format to record information on incidents in a consistent manner and was used to establish a uniform guideline for the investigation of pipeline failures. The study revealed that the most significant problem faced by pipeline operators, with respect to pipeline incidents, was excavation damage, particularly that caused by outside contractors (third parties). One of the purposes of this data collection effort was to compare operating practices and system failures to determine if a relationship could be developed between certain practices and failure modes.

The regulatory process consists of collecting information to define safety problems. Once problems are defined, alternative solutions are evaluated, and the best alternatives are published as a notice of proposed rule making. The public is given an opportunity to comment on the notices for a pre-established time period. In developing the 49 CFR Parts 190 and 192 Federal Safety Standards, over 500 separate comments, totaling 2,500 pages were received in response to the notices of proposed rulemaking (Docket OPS-3, 1970). The industry itself filed over 80 petitions to change 49 CFR Part 192 between the time the federal rules were issued and 1973.

After written and oral comments are received and evaluated, a regulation is drafted. For the Pipeline Safety Regulations, the Technical Pipeline Safety Standards Committee (TPSSC) was requested to review the proposed regulations and provide comments to OPS.

3.1 Technical Pipeline Safety Standards Committee

The Natural Gas Pipeline Safety Act of 1968 required the establishment of a 12-member TPSSC. This committee was appointed by the Secretary of Transportation to advise the Director of OPS on all proposed standards and amendments. The committee is required to prepare a report on the technical feasibility, reasonableness, and practicability of all proposed regulations. Since TPSSC had extensive pipeline knowledge and background, the OPS Director sought the committee's counsel on a variety of subjects beyond this required function, including reliance on the committee for technical and operational guidance throughout the development of the regulations. The OPS Director acknowledged that the regulations could not have been written within the two-year time frame set by Congress without the active technical assistance of the committee and especially the industry members.

The original TPSSC consisted of four industry experts, six public representatives, and five government officials. The members were selected to provide a balance of skill and knowledge by selecting representatives with specialized knowledge in each of the elements that make up pipeline operations. Although representatives from industry were members of the committee, their primary function was to provide technical expertise. On this committee, all members worked for the government and in the interest of the public. At the time, the committee members were offered compensation for their participation because OPS wanted the members to feel an obligation toward their role in the regulatory development and not to serve as representatives of their employers. The industry members declined the offer.

The TPSSC report on the original Minimum Federal Safety Standards under Parts 190 and 192 expressed concern that much work remained to be accomplished in future rulemakings to clarify the rules and to further improve the safety of pipeline facilities. Considering all aspects affecting safety was beyond the scope of the original time frame allotted to develop the regulations. The committee concurred on the final rule, but relied on assurances that supplemental rulemaking dockets would provide for further regulatory action in specific areas.

3.2 Philosophy

The pipeline industry was fortunate in that the original Pipeline Safety Regulations reflected the values and integrity of the first OPS Director, Mr. William Jennings. Mr. Jennings' philosophies and intentions shaped the regulations into a form that served the interest of both the public and the government, while preserving the support of the pipeline industry.[3] Mr. Jennings believed a regulation is a solution to a problem. He stated that without a well-defined problem, there is no need for a regulation. As such, problem definition is essential to developing the solution. Mr. Jennings felt that the regulator does not create abstract regulations in a social vacuum. Rather, he should seek regulatory solutions to problems as they are seen in light of the current social environment.

Some of the distinguishing considerations built into the regulatory development process, under Mr. Jennings' direction, include the following:

> **Relationship between cost and benefit –** The purpose of the regulations was to establish a standard of safety that would be acceptable to the populace at large. The cost/benefit aspect is not a mathematical formula, but rather a state of mind which considers both cost and benefit in

[3] More details on Mr. Jennings philosophy in developing the pipeline safety regulations are provided in a book that Mr. Jennings authored based on his experience in regulatory development. The document is provided in its entirety in Appendix C.

evaluating regulatory proposals, seeking to minimize the hazard to the public within the limits of economic feasibility.

Public participation – The development of regulations is a political process, balancing the needs of Congress, the public, and industry. Regulatory agencies perform a public function, and the participation of the public contributes to the validity of the regulatory process. Facts are best tested and conclusions best validated through the clash of opposing opinions. The pipeline safety regulatory process was open to the public, inviting public input at all steps and on all subjects. The public was provided ample opportunity to participate in the identification and definition of safety problems, the development of alternative solutions, and the choice of regulatory solutions (where regulation is appropriate).

Performance language – To the extent possible, the regulations were to be stated in terms of performance standards rather than design and construction specifications. That is, the regulations prescribe what industry must do to achieve adequate safety by stating the level of performance that must be met. Tests and analytical procedures are prescribed to measure performance.

3.3 Adopting Industry Standards as Regulations

Mr. Jennings and his staff could have adopted the B31.8 Code as the regulations, but Mr. Jennings believed that regulations should be developed by government, not industry.[4] However, he adopted the B31.8 Code as the interim regulations, pending publication of the new regulations. The Code was then used as a guide in developing the new regulations.

Regulations differ significantly in both format and function from industry standards. Regulations prescribe what industry must do, while industry standards recognize and recommend practices which experience has shown to be safe. The standards themselves become recommended practices, with no legal requirement for compliance.

Industry standards are developed by industry members, based on cumulative technical knowledge and experience, for the benefit of the industry. By adopting industry standards as regulations, the regulator in effect designates that which was designed as a recommendation to become a legal requirement. Any new or different proposal requires a one time exception or waiver. Therefore, the regulator controls the ingenuity and initiative of the industry in developing new technology and techniques, while industry standards encourage innovation and new technology.

3.4 Role of B31.8 and Industry

OPS sought a cooperative relationship with the industry, founded on the mutual interest of safety, and drawing on the experience and talent of industry. However, industry cooperation was not to be pursued at the price of a weak regulatory program or to the extent that the collaboration would be viewed by Congress as industry writing their own regulations.

The B31.8 Code was widely used, maintained, and developed during the 15 years before Congress passed the Pipeline Safety Act. With the publication of 49 CFR Part 192, the role of the B31.8 Committee was significantly diminished because they did not want to become an auxiliary to the federal rules group. 49 CFR Part 192 essentially replaced the B31.8 Code as the safety standard for U.S. gas pipeline operators. As a result, the U.S. gas pipeline industry lost interest in maintaining the B31.8 Code and turned its

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[4] Mr. Jenning's explains the reasons for this belief in Chapter 14 of *The Regulator's Handbook*, provided in Appendix B of this report.

attention toward interpretation of the regulations. At this point, activities of the B31.8 Code Committee ceased.
It was agreed that, upon publication of 49 CFR Part 192, a document, entitled *Guide for Gas Transmission Piping Systems,* would be created, containing information that gas pipeline operators could use to comply with the provisions of the Pipeline Safety Regulations. A recommended means of compliance with each requirement of 49 CFR Part 192 was developed by the Gas Piping Standards Committee (later renamed the Gas Piping Technology Committee, GPTC), a group formed from the membership and leadership of the B31.8 Committee. The *Guide* was initially sponsored by the American Society of Mechanical Engineers (ASME) and later approved as an American National Standard and given the designation of ANSI/GPTC Z380. The *Guide* is revised each time there is a change to 49 CFR Part 192.

The *Guide* was, and is, intended to be useful to pipeline operators in their efforts to meet the 49 CFR Part 192 requirements. For all practical purposes, U.S. gas pipeline operators at the time regarded the GPTC and the *Guide* as replacing the Code Committee and the B31.8 Code. The B31.8 Committee went into limbo during the 1970 to 1971 period. The industry did not believe that maintaining the Code in accordance with changing technology would serve any useful purpose since the industry could not use the new technology until it was incorporated into the regulations.

3.5 The Resurrection of the B31.8 Code

In the early 1970's, Phillips Petroleum Company was planning to construct a gas pipeline from its production facilities in the North Sea to the Norwegian mainland. The Norwegian government requested that Phillips provide the rules or code that would be followed in designing and constructing the pipeline. The oil company replied that it would follow the requirements of the B31.8 Code. During this process, it was discovered that if the B31.8 Code was not revised or reaffirmed by 1974, ASME rules required that it would cease to exist. The need for an international code was brought to the attention of the gas pipeline industry, and the B31.8 Code Committee was reactivated to reaffirm the Code and to develop procedures for offshore pipelines.

The Committees that oversee the *Guide* and the B31.8 Code are both very active in maintaining the status of their respective publications. The *Guide* is useful only for facilities that are subject to regulatory sections under the jurisdiction of the U.S. DOT. The B31.8 Code is applicable to pipeline facilities transporting gaseous fluids anywhere in the world and contains an entire chapter on offshore pipelines. For U.S. gas pipeline operations, except for rural gathering systems, the regulatory requirements of 49 CFR Part 192 take precedence over the Code.

4.0 Establishing the Threshold for Operating Pressure

4.1 Establishing Operating Pressure

Pipe for a particular line is generally purchased to a specified minimum yield strength (SMYS).[5] Operating pressure is then set lower than SMYS to incorporate a safety factor. A minimum design factor of 72 percent of SMYS was derived from the first all welded pipeline, installed by Natural Gas Pipeline Company of America in the 1930's. Because the use of an all-electric girth welded line was new, no precedent existed for operating pressure. It was determined that the pipe could be used safely at a stress level of 80 percent of the manufacturer's mill test pressure (typically 90 percent of SMYS), where 80 percent of the 90 percent of SMYS results in a maximum allowable operating pressure (MAOP) of 72 percent of SMYS. A 72 percent stress level first appeared in the 1935 American Tentative Standard Code for Pressure Piping. To establish a consistent basis for MAOP, the 1935 Committee agreed that mill test pressure would be that basis. This became an established practice and was proven safe through operation, and was thus accepted by the early Code Committee as the basis for establishing MAOP. Post testing was not an industry practice at the time the 72 percent of SMYS was selected. Only a gas leak test was performed. The only strength test conducted was the mill test.

It is important to note that at that time (1935) API Standard 5L (currently referred to as API Specification 5L) did not require line pipe to be tested to 90 percent of SMYS. Grade B pipe, for example, which has a SMYS of 35,000 pounds per square inch (psi), was required to be tested by the manufacturer to a hoop stress level in the range of 16,000 to 18,000 psi (about 50 percent of SMYS). However, by agreement between the purchaser and the manufacturer, some manufacturers were willing to test each piece of pipe to a level of 90 percent of SMYS. When the API 5LX specification (for the higher strength X grades) first appeared as a tentative specification in 1949, the standard mill test pressure level was established at 90 percent of SMYS. So, while the 72 percent of SMYS stress level was based on 80 percent of a mill test pressure equal to 90 percent of SMYS, it was not certain that all pipe made before 1949 was mill tested to 90 percent of SMYS. It was subsequently revealed that the vast majority of the mileage of natural gas pipelines in the United States was installed after 1949 when the 90 percent of SMYS from hydrostatic test by the pipe manufacturer became the norm.

The B31.1.8 Committee examined many pipelines in the United States while developing recommendations for operating pressure. Many of the members traveled across the country to look at how pipelines were built and operated. Some operators were using 80 percent of the actual yield strength established by hydrostatic testing, while others were field testing to much lower pressures. The end conclusion was to maintain the long established practice of using 80 percent of the 90 percent mill test pressure, resulting in an allowable maximum hoop stress of 72 percent of SMYS because it was proven to be safe through operational experience. The industry was under significant political pressure at the time, due to consideration of the Heselton Bill in Congress. So, they relied on the established experience, believing that they could defend it politically and because it did not penalize existing operations.

It should be noted that, although the maximum operating hoop stress in a natural gas pipeline was set at 72 percent of the SMYS from the pipe purchase contract, other sections of B31 based the allowable stresses on the minimum ultimate tensile strength (UTS). Design based on tensile strength, especially if done in the manner specified by the other B31 piping codes, would have been unnecessarily restrictive.

[5] The actual yield strength almost always exceeds SMYS, sometimes by as much as 15,000 psi.

4.2 Wall Thickness

In addition to using SMYS instead of tensile strength in determining MAOP, the gas industry also used nominal (or specified) wall thickness instead of minimum wall thickness in determining MAOP. At the time B31.1.8 was written, seamless pipe was widely used. The under-thickness wall tolerance for seamless pipe was much larger than pipe made from plate with a welded longitudinal seam. The industry did not want to specify wall thickness based on the seamless under-thickness wall tolerance. Basing pipeline operation on nominal wall thickness for 72 percent of SMYS accounted for operation with both seamless and plate pipe, and was justified through safe historical operation.

4.3 Steel Characteristics

Prior to 1949, the API Standard 5L covered steel Grades A, B, and C and other materials such as wrought iron. Grade C, the highest strength steel grade (SMYS = 45,000 psi), was discontinued in the 1930s and Grade B (SMYS = 35,000 psi) became the highest grade mentioned. However, purchasers could, and often did, obtain line pipe materials with SMYS levels above 35,000 psi by negotiation. For example, in building the original Tennessee Gas system (October 31, 1943) the SMYS that could be produced by a manufacturer for this system was 50,000 psi. A special steel alloy and plate rolling procedure were required to reach this strength level. At the time, the average actual yield strength of most of the pipe produced was 47,000 psi.

In 1949, the first tentative X-grade specification, API Standard 5LX, appeared. This specification provided requirements for Grade 5L X42 only (SMYS = 42,000 psi), but it stated that requirements for higher grades could be negotiated. Over time, the strength improved with better alloying and rolling techniques. By 1954, specific requirements for cold-expanded and non-expanded pipe in Grades X42, X46, and X52 were included in API Standard 5LX.

4.4 Early Testing Practices

A pre-service integrity validation by pressurizing the pipeline to a level above the maximum operating pressure was a method of insuring the reliability of pressure vessels. This safety practice was always an important part of the ASME Boiler and Pressure Vessel Code. Prior to the 1955 B31.1.8 Code, however, the post-construction/pre-operation test requirements for gas transmission and distribution piping stated that the line must be capable of withstanding a test pressure 50 psi higher than the maximum pressure at which the line is to be operated.

For early testing practices, gas was the common test medium. Proof testing with water is safer, since a rupture during a gas test can be very dangerous. Although proof testing with water was used in other industries, its use was very limited in the pipeline industry. The volume of water required to pressure test pipelines and the transportation of the water made hydrostatic testing prohibitively expensive and impractical, particularly in the climatically dry areas of the United States where many of the first long distance gas pipelines were constructed. In addition, operating problems may result if the water is not removed from the pipeline.

The use of natural gas as the test medium limited the test pressure that could be achieved because operators were reluctant to raise the pressure much higher than the expected operating pressure. One gas company recalled that they thought they had done well if they could reach a pressure of five or ten psi over the operating pressure. This was a potentially dangerous practice for the operators. When a pipe failure was initiated during gas testing, the potential energy and slow decompression of the natural gas would drive long, brittle-type pipe fractures.

The practice of hydrostatically testing pipelines to yield was initiated by Texas Eastern Transmission Corporation.[6] Texas Eastern had purchased two pipelines from the federal government, a 20-inch products line and a 24-inch crude line (also known as the Little- and Big-Inch pipelines), and converted them to natural gas. In the late 1940s, a number of pipeline incidents occurred on these lines, such that Texas Eastern's insurance carrier threatened to cancel coverage unless a program was developed to prevent further pipeline system failures. To verify integrity, Texas Eastern elected to test all of the 20-inch pipeline.

High-pressure hydrostatic testing was further examined by Battelle under the sponsorship of Texas Eastern and A.G.A.'s PRC over the time period from 1953 through 1968 (Duffy, 1968). This program examined test results from hundreds of miles of large diameter pipe using water as the test medium and at test pressures that would produce a transverse stress in the pipe wall equal to the SMYS. The benefits of hydrostatic testing documented by the program included:

- The ability to establish the real minimum strength of the pipeline as opposed to the mill tensile tests which are based on testing only about 1 percent of the pipe (to make this determination, the test must include a pressure/volume plot);
- The increased safety inherent in basing operation on an established minimum strength;
- The ability to remove significant defects originating in the plate mill, pipe mill, or during fabrication and installation; and
- The excellent service performance of lines tested to actual yield.

Participants in the program recommended that the allowable operating pressure should be set based on a percentage of the hydrostatic test pressure. They specifically recommended that the allowable operating pressure be set at 80 percent of the minimum hydrostatic proof test pressure when the minimum test pressure is 90 percent of SMYS or higher.

4.5 Regulatory Requirements

The Pipeline Safety Regulations (49 CFR Part 192) defined SMYS as the yield strength specified as a minimum in the pipe purchase order, keeping a consistent definition with the Code. However, for unlisted or unknown specifications, SMYS must be determined by tensile tests of the pipe.

When the 49 CFR Part 192 regulations were developed, the requirements for establishing operating pressure reflected those of the Code. However, the Code did not apply retroactively to existing pipelines. Based on comments from the Federal Power Commission and TPSSC recommendations, a grandfather clause was added to the regulations permitting the continued operation of pipelines at the highest pressure the pipelines had been subjected to in the five years prior to July 1, 1970.

[6] Baxter Goodrich, Vice President of Texas Eastern at the time, is given credit for this initiative.

5.0 Class Location Areas

5.1 1955 Code Committee

The 1952 edition of B31.1.8 allowed operation of a pipeline with a hoop stress of 72 percent of SMYS in all locations except those inside incorporated limits of cities and towns (Eiber, 1997). Within cities and towns, operators used heavier wall pipe to limit the maximum operating pressure to that which would produce a stress of 50 percent of SMYS. Unfortunately, the densely populated areas did not always align with the city limits. Many operators were specifying heavier wall pipe to reduce the stress level below 72 percent of SMYS in certain population areas and at road and railroad crossings, but the criteria were not uniform among operators (McGehee, 1998).

To address the complex problem of relating pipeline location to operating pressure and to re-examine the appropriateness of the 50 percent SMYS design limit for high population areas, the 1955 B31.1.8 Committee appointed a subgroup to study the problem. This subgroup flew over numerous pipeline routes with local gas company maps to examine the current practices of pipeline companies. Aerial photographs of all of the major pipeline companies in the country were used to determine population densities within the right-of-way along the routes.

The subgroup recommended that the width of the area for determining population density and defining pipeline construction and the right-of-way zone be one-half mile (i.e., a quarter mile on either side of the center line of the pipeline). This width was selected because a zone of this width was conveniently identified on typical aerial photographs used for locating pipelines. In addition, the Committee believed that this width provided a representative sample of the area traversed by a pipeline and especially the activity occurring around the pipeline.

The number of buildings intended for human occupancy within this half-mile zone was examined. A statistical compilation of the population densities within a quarter-mile of the pipelines determined that a house count of approximately 20 dwellings per one-mile length would have a negligible effect on the majority of the existing pipeline systems. In fact, less than 5 percent of the total transmission pipelines at the time were impacted by higher populations requiring stress levels below 72 percent of SMYS (McGehee, 1998). Due to heightened political pressure resulting from the Heselton Bill, the Committee agreed on a limit of 20 dwellings per mile as the maximum density for areas where 72 percent of SMYS is permitted. The Committee believed that this designation reflected the current practices of pipeline operators, was demonstrated safe based on current practices, and would be politically acceptable.

The Committee did not intend for this width to imply that the pipeline was unsafe in this area. Rather, as the number of houses around the pipeline increases, the expected activity near the pipe threatens pipeline integrity. The Code was based on the premise that if the design of the pipeline is adequate for the level of exposure of the pipeline to the public and the public to the pipeline, then an acceptable level of safety will be achieved.

In determining the population density near the pipe, it was not the intention of the Committee that the design or operating pressure of a pipeline be changed as soon as the house count exceeded the specified limit. The Code Committee examined the population within the half-mile zone at one-mile and ten-mile lengths to determine the potential for growth along the pipeline route. The resulting design limits developed for the Code included some provision for normal increases in population.

As a result of the population density study, the Code Committee established four class location types in the 1955 edition of the B31.1.8 pipeline Code. The class locations were designated to address the concerns of increasing potential damage to the pipeline due to population and nearby activities, as well as issues with the availability of heavier wall plate.[7] Increasing the wall thickness would provide additional safety if corrosion or increased third-party damage occurred in higher population areas. At a constant MAOP, the thicker pipe reduces the stress levels. Thicker pipe reduced the stress levels, and reduced stress levels increased the ability of the pipe to withstand limited pipeline damage without rupturing. The design identified the allowable hoop stress in certain locations. A survey of the industry conducted by the B31.1.8 Committee summarized failures and the corresponding stress levels and showed that, at the time, only one failure below a 50 percent stress level had resulted in a rupture.

The subgroup's review of current practices confirmed that there were many areas where pipeline operators chose to install heavier wall thickness pipe than that required for 72 percent of SMYS or operated at lower pressures. Results from the review indicated that the higher population areas were those typically served by distribution companies, which operated their pipelines at much lower pressures and less than 40% SMYS. By the time the transmission pipeline reached the city gate station, 50 or more miles from the last compressor station, the pipeline operating pressure dropped well below 72 percent of SMYS, and was often in the range of 35 to 40 percent of SMYS. The subgroup concluded that 50 percent of SMYS was appropriate for developed areas, but acknowledged that the pressure should be slightly lower for densely populated areas of high rises, such as downtown business districts.

The Committee maintained the original design factors of 72 percent of SMYS and 50 percent of SMYS, and added two new designations. A stress level of 60 percent of SMYS was added to account for areas between rural and urban and to address suggestions about using a heavier wall pipe for road and railroad crossings, as well as valve settings, drips, and other fabricated assemblies used in cross-country pipelines. For large cities, the Committee added a fourth class type, with a reduced stress level of 40 percent of SMYS, to address the greater potential for damage to the pipeline in these areas and because most of the pipelines installed in densely populated areas were currently operated below 40 percent of SMYS. A description of the design factors corresponding to each construction type and class designation is shown in Table 5-1.

When the population increased, the Code allowed reclassification to the next lower class provided pipeline operators retested the pipe to 125 percent of MAOP if operating pressures were to be maintained. Otherwise, the pipeline pressure had to be reduced. This Code requirement was much more stringent than any previous document.

5.2 Subsequent Changes by the B31.1.8 Committee

In the early 1960's (before the Federal Pipeline Safety Act was being considered by a congressional committee), several of the northeastern state regulatory agencies (led by the New York Public Service Commission) brought to the attention of the B31.1.8 Committee that there were no provisions in the Code dealing with population growth along a gas pipeline. The Code Committee recognized that this could present a significant safety and credibility problem regarding both the B31.1.8 Code and the Code Committee. The Committee developed and approved best practice inspections to provide an engineering basis so the Code could address this problem in a timely manner. These provisions appeared in the 1968 edition of the Code (in Paragraph 850.4).

[7] At the time, the availability of steel meeting the desired wall thickness and strengths was greatly limited.

Table 5-1. B31.1.8 Design Factors

Design Factor (% of SMYS)	Construction Type	Applicable Location
72	A	• Private rights of way in Class 1 locations • Parallel encroachments on private roads or unimproved roads in Class 1 locations • Crossings without casings of privately owned roads in Class 1 locations • Crossings in casings of unimproved public roads, hard-surfaced roads, highways, or public streets and railroads in Class 2 locations
60	B	• Private rights of way in Class 2 locations • Parallel encroachments on private roads, unimproved roads, hard-surfaced roads, highways, or public streets and railroads in Class 2 locations • Crossings without casings of privately owned roads and unimproved public roads in Class 2 locations; or hard-surfaced roads, highways, or public streets and railroads in Classes 1 and 2 • Crossings in casings of hard-surfaced roads, highways, or public streets and railroads in Class 2 locations • Bridges in Class 1 and 2 locations • Fabricated assemblies in Class 1 and 2 locations
50	C	• Private rights of way in Class 3 locations • Parallel encroachments on private roads, unimproved roads, hard-surfaced roads, highways, or public streets and railroads in Class 3 • Crossings without casings of privately owned roads and unimproved public roads in Class 3 locations, or hard-surfaced roads, highways, or public streets and railroads in Classes 2 and 3 • Compressor station piping
40	D	• All locations in Class 4

5.3 DOT Changes

Although OPS adopted the basic concept of class locations and corresponding design factors from the 1968 B31.8 Code, it modified the method of determining population density and chose a right-of-way width of one-eighth mile on either side of the pipeline. The federal rules also made a corresponding change in the number of buildings intended for human occupancy and added other criteria to include places of public assembly.

An informal telephone survey conducted by OPS was the basis for reducing the width of the area right-of-way from a half-mile to a quarter-mile. The survey and a review of federal failure reports indicated that the half-mile zone was not necessary since impacts from past incidents had not extended even as far as a quarter-mile. Therefore, a quarter-mile wide zone, extending one-eighth of a mile on either side of the pipeline, was more appropriate. The OPS study considered both the impact of increased population on the pipeline within this corridor width, as well as the potential risk of a pipeline incident to people or buildings within one-eighth of a mile, and concluded that the reduction would not have an adverse effect on safety.

In reducing the corridor width for determining the population density by half from what the 1955 Code Committee had developed, OPS also reduced the number of dwellings from 20 to 10 for Class 1 locations. OPS further refined the other class designations as follows:

- Class 2 – Any one-mile section that has more than 10 but fewer than 46 buildings intended for human occupancy. Class 2 was intended to reflect areas between Class 1 and 3.
- Class 3 – Any one-mile section that has 46 or more buildings.
- Class 4 – Any one-mile section where buildings with four or more stories aboveground are prevalent.

These changes were later reflected in the 1974 revisions to the B31.8 Code.

The federal regulations also removed the 10-mile population density index and set the "class location unit" as a one-mile length. The regulations included a requirement for uprating the pipelines whenever the population increase resulted in a class location change. OPS originally proposed a 60-day period to confirm or revise the MAOP after a class change, but revised it to one year based on comments received from the notice of proposed rulemaking (NPRM). A second amendment was issued in September 1971, extending the time period to 18 months to comply with the requirements of the location class change.

6.0 Valve Spacing

6.1 Code Considerations

Pipelines in place and constructed at the time the B31.1.8 Committee was initially meeting were predominately located in rural areas. The typical valve spacing in these areas was 18 to 20 miles, with accessibility being the primary factor for selecting the valve location. Based on economical and operating convenience, valves were installed about 20 miles apart (on longer pipeline segments such as 100 miles) so that routine pipeline maintenance could be performed without having to blow the natural gas pressure down to one atmosphere and purge the methane with air for the entire pipeline between compressor stations. Some companies recognized the need for reduced distances in higher population areas, anticipating the need for more frequent isolation of valve sections to repair or replace pipeline defects.

Operating convenience, economics, and the need to limit adverse publicity during an incident were the primary motivations for establishing valve spacing recommendations in the Code. Although it is often perceived that valve spacing is based on minimizing the consequences of a pipeline incident, in actuality the majority of damage from a pipeline rupture occurs in the first few minutes (Sparks, 1995; Sparks, 1998). If the gas is ignited, being able to close the valve quickly has no effect on safety but may minimize negative public perception. Timely valve closure may not significantly reduce the amount of gas released to the atmosphere (Sparks, 1995, 1998). Safety is best addressed in the Code by assuring that the valve is accessible, and unexpected gas losses are minimized.

The Code Committee surveyed industry practice in 1955 and suggested a requirement for valve spacing as a function of class location, as shown in Table 6-1. Specific intervals were designated to satisfy concerns of potential litigation associated with specifying valve spacing based on engineering judgement. The Code Committee intended the valve spacing recommendations to be used as guidelines, but for pipeline operators to also consider local conditions. For example, a valve located near a roadway is more readily accessible than one located in the middle of a pasture, cornfield, or swamp.

Table 6-1. B31.1.8 Valve Spacing Requirements

Class Location	Valve Spacing
1	20 miles
2	15 miles
3	8 miles
4	5 miles

These spacing intervals reflected the current practices of the majority of pipeline operators in 1955, while also responding to governmental and public pressure for more valves in higher population areas.

6.2 Regulatory Requirements

The valve spacing requirements in 49 CFR Part 192 were based on recommendations in the B31.8 Code, but were rewritten to more clearly express the intended result (Docket OPS-3). The TPSSC believed that valve placement was primarily an economic matter rather than a safety consideration. The increased number of valves required for higher population areas was based on minimizing the volume of gas released during maintenance activities and was not a decision based on public safety.

7.0 Inspection Frequencies

7.1 Code Considerations

The question as to whether the Code should contain provisions regarding the operation and maintenance of pipeline systems received considerable attention by the B31.1.8 Committee (Hough, 1955). Because many of the state codes contained such provisions applicable to gas transmission and distribution facilities, the Committee decided that the Code must also include these requirements if it was to be accepted by the state and federal regulators. However, the Committee also believed that it would be impractical to include specific, detailed requirements in a national industry standard.

The 1955 B31.1.8 Code stated that each company shall meet the following basic requirements regarding operating and maintenance procedures:

1. Have a plan covering operating and maintenance procedures that meets the objectives of the Code;
2. Operate and maintain its facilities according to this plan;
3. Keep records necessary to administer the plan properly; and
4. Modify the plan as needed as exposure of the public to the facilities and operating conditions require (Hough, 1955).

The Code listed the types of items that should be included in a maintenance program, but the list was not meant to be inclusive. Rather, the intention was to provide examples of the magnitude and detail that would be considered adequate by the Committee. The objective of the B31.1.8 Committee was that each operator should develop a comprehensive, well-managed program that:

> "...will put the company in compliance with the Code and will provide for a degree of maintenance that will go far toward eliminating any tendency on the part of government officials to try to spell out in detail the amount and extent of maintenance work that a company should do" (Hough, 1955).

It should be noted that the B31.8 Code, and the earlier B31.1.8 Code, did not specify intervals or frequencies for conducting specific maintenance and operating activities. The Code simply stated that periodic inspections or tests were required, and left the interval to be determined by the operator based on system specific conditions and prudent engineering practices. Some equipment, such as rectifiers and related corrosion control activities, are highly dependent on location specific conditions. An experienced operator knows that inspection intervals should be different for each set of circumstances.

7.2 Regulatory Requirements

Specific intervals were introduced when DOT issued the Pipeline Safety Regulations in 1970, replacing "periodic" with a defined interval that could be inspected/audited. The intent of the Code was to have each individual operator use an inspection level that was suitable for the local conditions in which the equipment operated. The intervals were based on general industry practices and available technologies at the time. Discussions among TPSSC members identified the common practices of the late 1960's.

8.0 Public Communications

8.1 Code Considerations

The issue of public education has been an industry concern since pipelines were first put in the ground. In fact, incident reports indicate that external force damage, such as those caused by excavation equipment, is the leading cause of pipeline damage and has been since the causes of pipeline incidents were first compiled in 1966 (Congressional Research Service, 1986).

Public communications and education were not explicitly addressed in the early editions of Code B31.1.8 or B31.8.[8] However, pipeline operators worked to maintain good public relations, particularly in areas where a pipeline was only accessible from an individual's property. Public education activities provided a means for pipeline representatives to meet landowners and gave landowners an opportunity to voice any concerns.

Voluntary industry participation in One-Call programs went a long way toward reducing damage to pipelines from outside sources. These programs were developed to make the general public aware of the pipeline, to encourage people to call prior to digging, and to encourage landowners to call if they saw someone else digging. To promote these activities, pipeline operators would often hold local meetings with contractors, public officials, landowners, farmers, and developers. Calendars and other giveaway items were also used to keep the gas operator's phone number readily accessible to the landowner. These activities are still used in practice today.

8.2 Regulatory Requirements

Requirements for public communication efforts were first included in 49 CFR Part 192.615 (Amendment 192-24 41 FR 13587 March 31, 1976) under the section on emergency plans. The regulations required pipeline operators to establish educational programs to enable customers and the general public to recognize and report a gas emergency. In 1994, these requirements were moved to a new section on public education efforts (49 CFR Part 192.616 Amendment 192-71, 59 FR 6585, February 11, 1994).

[8] A section on educational programs was added to B31.8 (850.44) in 1982 to enable landowners to recognize and report gas emergencies, including activities near a pipeline and any observed damages or leaks.

9.0 Conclusions

Based on the meetings held for this project, it is interesting to note that the concerns of the industry when the 1955 Code Committee was initially developing standards for gas pipelines remain the major concerns of operators today – maintaining the safety of the pipeline system while economically transporting natural gas.

The original B31.1.8 Committee designed the Code with three primary objectives:

1. To represent the established, good engineering practices used to develop, operate, and maintain the existing infrastructure, such that the industry would not be burdened with having to replace vast amounts of good pipe;
2. To make the standards acceptable to the federal government and the public, such that federal regulations (i.e., the Heselton Bill) would not be needed; and
3. To use in material and construction bid documents.

The Code was based on the technological developments of the time, and it was during this time that the industry was rapidly developing new technologies. The Committee wanted the Code to be applicable to current best practices, but flexible enough to provide for new innovations and experience gained by the industry. In fact, during this time, the PRC was formed to develop research efforts in support of the Code. As the research results became available, they were included in the technical discussions supporting the Code development and modifications.

The language used in the 1955 and 1958 versions of the Code was specifically chosen to be performance based. The Committee set out to document safe, acceptable practices and not to prescribe actions. Performance based language carried over into the original Pipeline Safety Regulations. In fact, many of the broad, philosophical considerations of the Code served as the foundation of the Regulations as well.

In the current regulatory environment, it is important to observe that the original intent of the Code was performance and was not to be as prescriptive as the requirements imposed by regulations. To facilitate enforcement, regulations have moved away from being performance based to being more prescriptive. Over time, the Code has been modified to more closely reflect the regulations. For all practical purposes, the U.S. pipeline operators are not compelled to use the Code because the U.S. pipeline industry is regulated by 49 CFR Part 192.

A worldwide initiative is currently underway to develop an international code for pipelines: *ISO/DIS 13623 Pipeline Transportation System for the Petroleum and Natural Gas Industries*. This document is written to satisfy all world conditions related to pipelines. The current B31.8 Committee is also trying to make the Code more applicable to international operations since many of the U.S. gas pipeline companies have or are developing international interests.

Technological developments and engineering advances continue to improve pipeline operations and safety. The pipeline industry works to incorporate these changes into their codes and standards, and the continued development and use of the Code complements the development of the regulatory requirements. Through an understanding of the Code's foundations, the current gas pipeline industry has an opportunity to work with OPS to restore the original performance intentions of the Code and to provide for continued public benefit and improved safety.

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Mr. Bob Eiber
Mr. William Jennings
Mr. John Kiefner
Mr. Angus Macdonald
Mr. Burt Mast
Mr. George McClure
Mr. Wes McGehee
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Mr. A.T. (Red) Tyler
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Mr. George White

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Frank Williams: Mr. Williams served as executive chairman of B31.1 and later became chairman of the ASME Boiler and Pressure Vessel Code. Mr. Williams is remembered for his vision and leadership in developing the first comprehensive pipeline Code.

Fred Hough: Mr. Hough was the first Chairman of the B31.8 Code for Pressure Piping Committee. Formerly, he was Vice President of Southern Counties Gas Company and later a consulting engineer with Bechtel Corporation. Because of his leadership and persistence, Mr. Hough is credited for the Code being what it is today.

APPENDIX A

MEETING PARTICIPANTS

The following emeritus participated in the meetings:

Bob Dean: Mr. Dean spent 42 years with Tenneco, where his work experience included drafting, field construction, and supervision. At Tenneco, Mr. Dean moved into Codes and Standards, where he became a B31.8 member and a member of the Gas Piping Technology Committee (GPTC). For 15 years, he served as Vice Chairman of the American Petroleum Institute (API) Committee on Standardization of Tubular Goods and Chairman of the Users Subcommittee on Line Pipe. He has been consulting in the gas industry since 1988.

A.J. (Del) Del Buono: Mr. Del Buono began his career in the gas pipeline business in 1946 with Michigan Consolidated Gas Company, where he worked in specifying, designing, and testing piping components. He also spent three years with Bechtel Corporation in Europe building the Trans-Alpine Pipeline. After attending one of the earliest B31.8 meetings in 1951, Mr. Del Buono went to work for Frank Williams to assist him in research efforts for the B31.8 Committee. He remained active on the Code Committees and was a member of both GPTC and B31.8. He retired from ITT in 1986 to work as a consultant.

Robert Eiber: Mr. Eiber retired from Battelle in 1994 and established a consulting business. Recent studies with Wes McGehee document some of the background for the current MAOP requirements in the U.S. compared to requirements in other countries, the criteria for block valve spacing, and a comparison of class location codes. While at Battelle, Mr. Eiber, along with John Kiefner and George McClure, was involved in the research that defined the basis for Code changes.

John Kiefner: Dr. Kiefner currently operates an engineering company, Kiefner and Associates, Inc., which he established in 1990 after leaving Battelle. Kiefner and Associates, Inc. conducts pipeline research efforts for research organizations, such as GRI and the Pipeline Research Committee, as well as for pipeline operators. His background in pipeline research with Battelle is in the area of remaining strength of corroded pipe.

Angus Macdonald: Mr. Macdonald has been working as a consultant since 1970. Previously he worked for Kaiser Steel Corporation as a metallurgist, with expertise in the area of integrity analysis. He is an active member of the B31.8 Committee and the API Committee on Standardization of Tubular Goods.

Burt Mast: Mr. Mast worked for United Gas Pipeline from 1936 to 1942. After serving in the Air Force during World War II, he went to work for Tennessee Gas in 1946. At that time, Tennessee had a single 24-inch line and they were just starting to build a second line. During most of the 13 years he was with Tennessee, he was the Supervising Engineer. In 1954, he went to work for Trunkline Gas, where he served as a Chief Engineer and Vice President for 13 years. Mr. Mast was a member of the B31.8 Committee and chaired the Design Stresses Subcommittee of the 1955 Committee. He was also one of the charter members of the Technical Pipeline Safety Standards Committee (TPSSC) and served as chairman for ten years. After retiring from corporate life in 1967, Mr. Mast became a consultant.

George McClure: Mr. McClure spent 38 years of his career at Battelle. He was introduced to pipeline research within a few months of joining Battelle in 1949. He became involved in the early American Gas Association (A.G.A.) Pipeline Research Committee work at Battelle and supervised the work until the late 60's or early 70's when he became an Assistant Director of Battelle's Columbus Laboratory. He was a member of B31.8 and attended all of the meetings until the early 1970's to provide input on the pipeline research efforts. Mr. McClure retired from Battelle in 1987.

Wes McGehee: Mr. McGehee worked for Texas Eastern for 25 years, where his industry background includes Plans and Research, Technical Services, Engineering, and Operations. Since 1986, he has operated a consulting service, where he works primarily with gas and oil pipeline companies. His expertise is in the areas of hydrostatic testing, pipeline maintenance, operation, design, and construction. Mr. McGehee presently serves as the Chairman of the ASME B31.8 Committee.

Al Richardson: Mr. Richardson worked for Tennessee Gas Pipeline for more than 37 years. He is currently president of Richardson Engineering out of Marble Falls, Texas. He has been involved with B31.8 for a number of years and worked for Bob Dean when he was deeply involved in B31.8. Mr. Richardson was witness to the transition from the engineers that built the original pipeline system to the current engineers that operate it today, and has observed the cultural differences between the two groups.

Andy Shoup: Mr. Shoup trained in Civil Engineering and spent most of his career working in the pipeline industry. He initially worked for United Gas, where his first job, in 1939, was building several natural gas pipelines near Monroe, Louisiana. He later spent 25 years at Texas Eastern serving as Vice President and Chief Engineer, Senior Vice President, President, and Chief Executive Officer of Transwestern (a subsidiary of Texas Eastern at that time). He was a charter member of TPSSC and worked on a number of other committees, including B31.8, the Pipeline Research Committee, and other operating committees. He retired in 1971 to become a consultant. In 1974, he was appointed to a court position as Director and Chairman of the Board of LoVaca, which he served until 1982.

Mr. Shoup was a charter member of the B31.8 Code Committee and served as Chairman of the Committee for 18 years. He was also a member of the Design Committee and Pipeline Committee. He retired from the Code Committee in 1990.

A.W. (Red) Stanzel: Mr. Stanzel spent his career with American Natural Resources Pipeline Company. He was involved in the A.G.A. NG-18 Committee for a number of years, and served as Chairman for the last ten years of his career. His areas of expertise include hydrostatic testing and field failure investigation.

A.T. (Red) Tyler: Mr. Tyler began his career in 1941 as a construction engineer for Mene Grande Oil Company. Over the years he has worked for numerous other pipeline companies and engineering companies serving the pipeline industry. He chaired the Design, Installation, Testing and Welding Task Group of the B31.8 Committee, and currently serves in the Executive Committee. Mr. Tyler is also a member of the WG-3 Design Committee for the International Standards Organization (ISO) TC 67 Petroleum and Natural Gas Industries - Pipeline Transportation Systems. He also represents the U.S. on the ISO Committee to develop an international standard for pipelines. He is currently President and CEO of International Pipeline Engineers, Inc.

Tiny Von Rosenberg: Mr. Von Rosenberg has worked in the pipeline industry for 32 years. Over 20 years of this time was spent at Exxon in their research laboratory, where he was instrumental in developing and validating an early analytical model of fracture arrest of propagating ductile fractures. He has wide experience with the design and construction of onshore, offshore, and arctic pipelines. He was involved in the design and construction of the

Alyeska Pipeline. After retiring from Exxon in 1986, he organized a consulting firm and has continued his work in both pipeline materials and welding applications.

George White: Mr. White worked for Tennessee Gas Pipeline Company for 38 years, most of the time as Chief Engineer and Vice President. At the time OPS adopted 49 CFR Part 192, he was Secretary of the B31.8 Committee and also served on the API 5L Users Line Pipe Committee. Mr. White was also a charter member of the original TPSSC, serving for three years. Mr. White and Mr. Mast were instrumental in convincing OPS that the original B31.8 Code was the only standard at the time that could serve the industry.

The following former OPS staff also participated in this effort:

William Jennings: Mr. Jennings headed the Law Department of Western Airlines prior to his appointment in 1962 as Executive Director of the Regulatory Council of the Federal Aviation Agency (FAA). In 1966, he was appointed Chairman of the Department of Transportation's Hazardous Materials Regulations Board and also served as Director of the Office of Hazardous Materials. In 1968, Mr. Jennings was named acting Director of the OPS and entrusted with developing the first Pipeline Safety Regulations. He left government service in 1970 to pursue other interests.

Joseph Caldwell: Mr. Caldwell began his career as a safety engineer for an insurance company, where he developed a petroleum oriented safety program for their clients. He then went to work for the FAA as the Regional Safety Engineer. In 1964, he became the Director of Ground Safety for the FAA in Washington D.C. and was there when the Department of Transportation (DOT) was formed in 1966. His 17 years at DOT began with the drafting of the Pipeline Safety Act in 1968 and continued through development and implementation of the basic pipeline safety regulations for both gas and hazardous liquid pipelines. Mr. Caldwell served as the Deputy Director and later Director of the OPS. For the past 14 years, Mr. Caldwell has been a consultant to the pipeline industry and related industries, state and federal agencies, and the public on matters relating to pipeline safety and safety regulations.

Other attendees at the meetings included:

Keith Leewis (moderator and GRI Project Manager): Dr. Leewis currently works for the Gas Research Institute, where he has been instrumental in developing the risk management applications for pipelines. His background is in metallurgy and welding. Prior to GRI, he worked on the TransCanada Pipeline system, with experience in failure analysis, automatic welding, x-ray, and non-destructive testing. He has also been involved with the Pipeline Research Committee *I*nternational (PRC*I*), first as a contractor and then as a pipeliner.

Jim Kelly: Mr. Kelly works in the Codes group for Duke Energy and currently serves on the B31.8 Committee.

Daron Moore: Mr. Moore is responsible for Codes and Standards and pipeline safety operational risk management at Tennessee Gas Pipeline. He is active on the B31.8 Committee and GPTC.

Andy Drake: Mr. Drake is Manager of Codes and Standards at Duke Energy.

APPENDIX B

1955 B31.1.8 COMMITTEE MEMBERS

1955 B31.1.8 Committee Members

Officers (to January 1955): F. A. Hough, Chairman W.H. Davidson, Vice-Chairman C.F. de Mey, Vice-Chairman C.T. Schweitzer, Secretary	**Officers** (after January 1955): J.H. Carson, Chairman W.H. Davidson, Vice-Chairman C.F. de Mey, Vice-Chairman J.F. Eichelmann, Vice-Chairman B.C. White, Vice-Chairman
Subgroup Chairmen (to January 1955): M.C. Madsen, Compressor Stations M.H. Davidson, Construction, Testing, and Operating B.T. Mast, Design Stresses F.G. Sandstrom, Distribution F.S.G. Williams, Fabricating Details and Mechanical Design C.F. de Mey, Pipe J.F. Eichelmann, Scope S.A. Bergman, Investigation of Transmission and Distribution R.D. Smith, Storage in Pipe	**Subgroup Chairmen** (after January 1955): B.T. Mast, Compressor Stations F.G. Sandstrom, Distribution S.A. Bergman, Facility Failures W.M. Frame, Materials F.S.G. Williams, Mechanical Design and Fabrication H.L. Stowers, Research F.A. Hough, Scope R.D. Smith, Storage in Pipe J.J. King, Transmission

Members:

Clyde D. Alstadt Columbia Gas System Service Corporation	John H. Carson The East Ohio Gas Company	G.G. Dye Southern California Gas Company
H. Bruce Andersen Philadelphia Gas Works Company	R.A. Cattell Petroleum & Natural Gas Branch U.S. Bureau of Mines	W.M. Frame National Tube Division United States Steel Corporation
Richard Aubrey Kaiser Steel Corporation	O.W. Clark Southern Natural Gas Company	John F. Eichelmann El Paso Natural Gas Company
Stephen A. Bergman Panhandle Eastern Pipe Line Company	Anthony H. Cramer Michigan Consolidated Gas Company	Julian L. Foster Lone Star Gas Company
Victor F. Bittner Peoples Gas, Light & Coke Company	F.G. Crawford The Fluor Corporation, Ltd.	George E. Fratcher A.O. Smith Corporation
Norman F. Blundell Gulf Interstate Gas Company	Kirby E. Crenshaw Gas Advisers, Inc.	John L. Gere Cities Service Gas Company
Mathew M. Braidech National Board of Fire Underwriters	Walter H. Davidson Transcontinental Gas Pipe Line Corporation	James W. Hall Hallmac Construction Company
J.A. Bramblett Fall River Gas Works Company	Charles F. de Mey Columbia Gas System Service Corporation	M.M. Heller United Gas Pipe Line Company
Fred H. Bunnell Consumers Power Company	C.A. Dunlop Humble Oil and Refining Company	E.L. Henderson United Gas Corporation

1955 B31.1.8 Committee Members, continued

E.N. Henderson Arkansas Louisiana Gas Company	M.C. Madsen Northern Natural Gas Company	J.C. Siegle Youngstown Sheet & Tube Company
Robert F. Henderson Ford, Bacon and Davis, Inc.	B.T. Mast Trunkline Gas Company	D.P. Smith Michigan – Wisconsin Pipe Line Company
C.A. Henrikson United States Pipe & Foundry Company	George W. McKinley Hope Natural Gas Company	Roscoe D. Smith Pacific Gas and Electric Company
Hugh H. Hunter Public Service Commission of Maryland	P.A. Mills Moody Engineering Company	B.W. Snyder Canadian Western Natural Gas Company Ltd.
Frederic A. Hough Bechtel Corporation, Pipeline Division	George D. Mock Washington Gas Light Company	Professor M.G. Spangler Iowa State College
Hugh H. Hyde Bechtel Corporation	J.J. Murphy M.W. Kellogg Company	F.E. Stanley Midwestern Constructors, Inc.
Lloyd R. Jackson Battelle Memorial Institute	Henry W. Nicolson Public Service Electric and Gas Company	H.L. Stowers Texas Gas Transmission Corporation
Carl T. Kallina Federal Power Commission	Paul E. Noll United States Steel Corporation	Professor Harry Udin Massachusetts. Institute of Technology
L.W. Kattelle Walworth Company	Preston Parks Colorado Interstate Gas Company	J. Thompson Vann American Cast Iron Pipe Company
J.J. King Tennessee Gas Transmission Company	M.J. Paul Natural Gas Pipeline Company of America	P.K. Wallace Oklahoma Natural Gas Company
W.P. Kliment Crane Company	J.R. Reeves Dominion Natural Gas Company, Ltd.	B.C. White Stone & Webster Engineering Corporation
Carl F. Koenig, III DeLaval Steam Turbine Company	F.G. Sandstrom Consolidated Edison Co. of N.Y., Inc.	Frank S.G. Williams Taylor Forge & Pipe Works
H.W. Ladd Stanolind Oil & Gas Company	W.H. Savage Robert W. Hunt Company	Carl K. Wirth State of Michigan Public Service Commission
Henry C. Lehn	C.T. Schweitzer Southern California Gas Company	Dean M. Workman Ebasco Services, Inc.
Giles R. Locke Republic Steel Corporation	A.J. Shoup Texas Eastern Transmission Corporation	Professor E.C. Wright University of Alabama

APPENDIX C

THE REGULATOR'S HANDBOOK

THE REGULATOR'S HANDBOOK

William C. Jennings

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by

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2757 No. Quebec St.
Arlington, Virginia

CONTENTS

A NOTE TO THE READER

This handbook presents some of the philosophic and procedural principles which I have found to underlie governmental regulatory programs. My firsthand experience is limited to safety regulations, but the general principles are equally applicable to other regulatory programs.

I resigned from government services last year after eight years in various regulatory programs, covering air, land, sea, and pipeline modes of transportation. I first served as Executive Director of the Regulatory Council of the Federal Aviation Agency then as Chairman of the Hazardous Materials Regulations Board in the Department of Transportation; while serving in the latter capacity. I was also Director of the Office of Hazardous Materials and Acting Director of the Office of Pipeline Safety. Before joining the Federal government, I worked for more than seven years in a highly regulated industry as Director-Corporate Law for Western Air Lines. Thus the principles stated in this handbook are confirmed by my own experience on both the government and industry sides of the table.

While I now take the initiative in collecting and articulating them, I am but one of the developers of these principles. They are the product of discussion among knowledgeable people in and out of government. I cannot name everyone whose contributions are reflected here, but I must give special credit to James B. Minor and Fred J. Emery whose trusted counsel was a boon to me and other administrators of the various regulatory programs in the Department of Transportation.

Each of my governmental positions had been recently created when I was appointed to it, so there was not much written guidance. In fact, part of my assignment in each case was to develop policies and procedures for performing the function. Reviewing my government service at the time I resigned, I found that the written instructions I had issued were nothing to be proud of. So, as my valediction to government services, I decided to write this handbook. My associates of recent years will readily recognize it as a collection of the bits and pieces of advice and instructions I gave orally through the years.

At the risk of appearing unscholarly, I have not supported the text with footnotes, because footnoting would be counterproductive. The theme of the handbook is that many regulatory agencies should change some of their present policies and procedures. I have described the problem areas in general terms without supporting specifics. Citing examples in footnotes would probably make the administrators of the cited programs feel defensive about their present practices. These administrators would be less receptive to a suggestion to adopt new practices, if the suggestion started off by putting them in the position of having to defend present practices. I have identified these problem areas through years of personal observation of many programs plus reading the Federal Register, where most regulatory agencies finally gave the public a look at their practices.

The two principal types of administrative agency actions are generally described as adjudicative and legislative in nature. Congress has prescribed different procedures for these actions, as discussed in detail in the Attorney General's Manual on the Administrative Procedure Act. By ignoring the intricacies, it is easy to highlight the differences in the procedures.

Adjudicative action by an administrative agency is similar in many ways to a trial in a court. The agency holds a formal hearing and then bases its decision on evidentiary facts which are made a matter of record by the testimony of witnesses who are subject to cross-examination by interested parties. The agency applies predetermined standards in deciding what will be done under the specific set of facts.

Adjudicative actions usually deal with the grant or denial of rights or benefits, such as licenses. This handbook does not deal with adjudicative actions.

Legislative action by an administrative agency is similar in many ways to enactment of a law by Congress. The agency issues regulations prescribing what may, or may not, be done in the future by those subject to its authority. The rulemaking procedures are informal. The agency is free to collect information in any way and from any source without any requirement for cross-examination or other validation of the information. The agency need not base its regulations on a factual record; it may rely on its own experience and expertise in deciding what regulations to adopt. About the only formal requirement is that, before issuing a regulation, the agency must publish a notice of proposed rule making and give the public an opportunity to comment on the proposal.

Lest someone misread my intent in pointing up the lack of procedural requirements in legislative actions, I must say that I do not believe that more procedural requirements would produce better regulations. In fact, more formalized procedures would probably have a negative effect by giving the regulated some procedural devices with which to prevent agency action. Improvement in a regulatory program lies not in procedural requirements, but in the regulator's desire to better serve the public. This handbook suggests some philosophic concepts and management devices to help the regulator who has that desire.

These few words need definition as to their use in this text:

> *Agency* means an administrative agency which takes legislative action, since the handbook does not purport to cover those agencies which take adjudicative action. In multi-purpose agencies, it means only the regulatory function within that agency.
>
> *Regulator* means the person in an agency who has authority to issue a regulation. It may be the head of the agency or some subordinate to whom he has delegated signature authority. Regulator is sometimes used to personify the regulatory function, encompassing the staff as well as the regulator himself, treating the staff as an extension of the regulator.
>
> *Regulation* means a requirement (including a negative requirement, or prohibition) of general applicability; that is, it applies equally to all similarly situated persons. It may be used in a plural as well as a singular sense, ranging all the way from a one-line requirement to a whole body of requirements on a single subject. Each new regulation is usually an addition to, or change in, an existing regulation.
>
> *Regulated* (when used as a noun) means those who are subject to a regulation. They may be individuals, partnerships, or corporations, including the individual employees who perform regulated functions.

With thanks to those who helped develop these principles, I dedicate this book to those regulators who are more interested in doing a job than in keeping a job.

June 1971 William C. Jennings

A. SOME UNDERLYING CONCEPTS

1. A REGULATION IS A LAW

What is a regulation? The answer to this question should permeate agency lore, but it frequently receives only scant attention. Many people in regulatory agencies, at times even the regulator himself, do not appreciate the legal effect of the regulations they issue. They may fail to distinguish between those things which are critical (regulations) and those which are desirable (advisories). They sometimes act as though regulations were contracts to be negotiated with the regulated or shields published to protect the agency from criticism.

Within the limits of the authority delegated to him, the regulator makes the regulations which Congress would make if it had the time and talent. A regulation is a law. A regulation has as much legal effect as if it had been passed by Congress and signed by the President.

A regulation is a legally enforceable requirement, whether stated in the affirmative or negative. It may require performance of an act, or it may require that an act (if performed) be performed in a stated way. It may prohibit an act altogether, or it may prohibit an act under stated circumstances. Whether affirmative or negative, a regulation is mandatory, not precatory. The agency may publish advisory material in support of its regulatory mission, but those subject to its regulation do not have to follow its advice.

Some agencies do not make a clear distinction between regulation and advice. They publish a hodgepodge of material (regulations, notices, orders, bulletins, standards, instructions, advisories, permits, etc.) without identification of those which have the force of law. Without this identification, those who must comply with the regulations may not be able to determine which material must be obeyed as law and which may be treated as advice. The agency's employees who are charged with getting compliance with the regulations may be similarly confused. In the interest of orderly administration of its programs, the agency must first discipline itself to distinguish between regulatory material and advisory material and then publish them separately.

The agency's mission is to protect the public from the things which the regulated industry might do if there were no governmental intervention. Many agency functionaries compromise their effectiveness by a too-close relationship with the regulated. The relationship is too close when those subject to regulation question the right of the regulator to make unilateral decisions or when the regulatory staff forgets that the function of the agency is to protect the public, not the regulated. The agency cannot function effectively without the active participation of the regulated in the regulatory processes, so close cooperation is required. But the regulator must guard against letting his position degenerate to the point of bargaining with those subject to regulation or letting their influence reach the point of controlling agency action. As it involves them in the regulatory processes, the agency must seek the cooperation of the regulated, not submit to their control.

Some regulators stumble from one crises to another, so preoccupied with building paper parapets to protect themselves from criticism that they have little thought for their governmental role. With little qualm, they dissipate agency resources genuflecting before newspaper headlines and Congressional criticism, taking superficial defensive action in response to individual accidents, imposing unnecessary burdens on the regulated just to take the heat off themselves. Regulators abuse their lawmaking authority when they put it to this use.

2. A REGULATION IS A SOLUTION TO A PROBLEM

Agencies frequently act in ever-greater detail in matters with which they are familiar, without considering whether there is need for more detailed regulation in that area. Aware of the need for a show of activity, they act on those matters with which they feel comfortable, copying from well-thumbed forms. Some agencies seem to lack a sense of direction, making no distinction between random activity and priority action on identified problems. Few agencies really focus staff energy on solving priority problems.

A regulation is a governmental solution to a problem. Until a problem has been identified, there is no need for a regulation. Until a problem has been defined, there can be no rational regulation. From the time a problem is identified until it is solved, the amount of agency effort devoted to defining and solving that problem should relate to the seriousness of that problem in relation to other identified problems.

In the absence of any better information, newspaper headlines may identify problems, but the agency is in sad shape if it has so few sources of information that it must rely on headlines to set the regulatory process in motion. The well-run agency identifies problems by analysis of information, systematically accumulated from sources such as accident and incident reports, and projection of problem potential. This does not mean that the agency should passively collect statistics and wait for the statistical evidence to grow so large that the existence of a problem is self-evident. On the contrary, the agency must constantly project the potential for occurrence of a problem, taking into account the incidents which could have been accidents and the minor accidents which could have been major under different and reasonably predictable circumstances. The agency has identified a problem when it foresees, under reasonable predictable circumstances, a threat of unacceptable harm to the public.

Some problems can be identified on the basis of common knowledge, without reference to accidents or incidents. Some years ago the Administrator of the Federal Aviation Agency noted that pioneer airline pilots were getting along in years, some past 60 years of age. Even absent accident/incident information, he knew that human faculties deteriorate with age and that these pilots were becoming progressively less capable of safe performance. Further, he could not wait for his knowledge to be confirmed by accident/incident information. Based on commonly accepted knowledge of the effect of aging, he issued a regulation prohibiting pilots from flying in airline service after age 60. Problems resulting from developments in technology may also be identified without accident/incident information, particularly the need for specialized training and qualification to handle new equipment. But with few exceptions, the best way to determine what will happen is to study what has happened, in the light of common knowledge and Murphy's Law: if it can happen, it will happen.

Once a problem is identified, the agency's next concern is to define the problem. Most regulatory programs suffer from the tendency of the regulatory staff to by-pass the definition step, attempting to go directly from identification to solution. The agency has defined the problem when, with reference to a particular kind of threat, it has reduced to writing the elements which constitute the threat. For problems relating to transportation safety, this list is illustrative:

- The number of accidents which have occurred in the past and the rate at which they are currently occurring;

- Whether the ratio of accidents is increasing: whether the number of accidents is increasing out of proportion to the increase in the volume of traffic;

- Where and under what circumstances the accidents are occurring, noting any change from historic patterns;

- The cause or causes of the accidents and, if more than one cause, the relative prevalence of each cause, noting any change from historic patterns;

- The damage resulting from each accident and whether the kind and amount of damage is greater than the historic pattern;

- A projection of the damage which may be expected in the future, based on historic patterns; and

- A projection of the maximum damage which might reasonably result from an accident of this kind and probability that such an accident might occur.

The regulator may take emergency action on less information than this, but he should promptly complete the definition process to test the validity of his action. And he should not hesitate to amend the emergency action, if the additional study shows that amendment is in the public interest. A regulator should never hesitate to amend any regulation in the public interest, particularly an emergency regulation which is necessarily issued on less than complete information. Most so-called emergencies arise out of either a failure to take timely action on available information or some technologic development which the regulations do not accommodate. An alert agency will never permit either of these "emergencies" to arise.

Once the problem is defined, the regulator and his staff are ready to address themselves to a solution-and not one minute earlier. The solution may be a regulation, advisory material, or other action, but it cannot be devised until the problem is defined. Some may view problem definition as an impediment to regulation; quite the contrary, it is a requisite-at least to rational regulation. Undoubtedly there will be those who use the requirement for problem definition as an excuse for failure to regulate. But they would have found some other excuse, if there had not been this one.

Most problems may be solved in more than one way. (This cautionary note: most regulatory solutions are but ameliorations.) The regulator should search for all possible solutions, make a cost/benefit analysis of each, and adopt the solution which he deems to give the public the best protection, within the limits of technical feasibility and economic practicability. Ultimately, this is a matter of the regulator's judgment.

To illustrate, consider the problem created by the escape of chemicals from railroad tankcars when they are ruptured after a derailment, a major factor in Congress' decision to pass the Federal Railroad Safety Act of 1970. The solution lies in reducing the frequency with which individual tankcars are ruptured and in reducing the number of tankcars ruptured in any one derailment. While most of the headlines concern accidents in which great quantities of chemicals were released, the rupture of a single tankcar of such commonplace chemicals as chlorine or anhydrous ammonia could cause a catastrophe. The Administrator of the Federal Railroad Administration will have a number of regulatory alternatives to consider in solving this problem. For illustration only, not as the end product of the identification/definition/solution process, these might be the alternatives:

- Require better maintenance of roadbeds and running gear (trucks, wheels, and axles) to reduce the number of derailments;

- Require better couplers on all cars to reduce the danger of tankcars being struck and ruptured after a derailment; and

- Require that tankcars be shielded to reduce the number of punctures even when the cars strike each other.

The first alternative might be more expensive and would be borne almost entirely by the railroads, but note that the benefit runs to the whole railroad operation, not just to the tankcars. The second alternative might be second most expensive and would be borne in part by the shippers who own the tankcars; it would not prevent derailments, but in case of derailment it would decrease the damage to the whole train, not just to tankcars. The third alternative would not prevent derailments and would protect only tankcars in case of derailment; the cost would be borne largely by the shippers who own most of the tankcars. Requiring all three would do the most to prevent the escape of chemicals, but the Administrator has to consider the economic practicability of any proposed regulation. How much money do the railroads and the shippers have to spend on this problem? Would the cumulative benefit of all three proposals be great enough to justify the additional cost of adopting more than one of them? Since any transportation cost is ultimately passed along to the shipper, would the added cost cause shippers to divert any of the chemicals to truck transport? If so, would public safety be enhanced by having the chemicals move by truck? Assuming that the third alternative is less effective than either the first or second and assuming that the railroads show that they do not have the money to comply with either the first or second alternatives (as the largest, the Penn Central, could probably show), the regulator would then have to issue the least effective alternative as a regulation, because it is the one which is economically practicable. This illustrates the central fact of this kind of regulation: money is the principal limiting factor.

3. NO PROBLEM, NO NEED FOR REGULATION

The books are full of regulations which are there because "they're already doing it anyway, so it won't be any burden on anybody" or "we've got to do something, because we're getting a lot of static, and this is about the most innocuous thing we can do." Or maybe some staff member started writing regulations long ago in some specialized field-and no one has ever questioned whether there is a continuing need for more regulation in that field.

If there is no problem, there is no need for a regulation. The regulator should not adopt a regulation simply because someone asked him to do so. Nor should he act on the assumption that those subject to this regulation will act irresponsibly.

This chapter is a corollary to the preceding chapter. If the regulator does not keep in mind the problem/solution nature of the regulatory function, he will divert his agency's resources from priority projects and saddle those whom he regulates with ill-conceived or unnecessary requirements.

When the regulator ignores the problem/solution relationship, he may be trapped into adopting a regulation which gives one member of a regulated industry a competitive advantage over other members. Many examples may be found among the present transportation regulations. Though public safety was their stated purpose, many of these requirements were developed and proposed by regulated companies-and similar requirements are still being proposed-for no reason but competitive advantage. The regulator cannot obligingly adopt everything which is wrapped in safety rhetoric. He must be as diligent in avoiding an unnecessary regulation as he is in developing necessary regulations.

If an industry acts so carefully that it does not threaten risk of harm to the public, there is no need for governmental intervention to protect the public from that industry's acts. This concept is clearly shown in the legislative history of the National Traffic and Motor Vehicle Safety Act of 1966 (15 U.S.C. 1381). If the automobile manufacturers had spent as much money on safety as they spent on style, they probably would not be subject to regulation today, because there would be no need for regulation. Since absolute safety is not attainable, the regulator must exercise his judgment in determining when the actions of those whom he regulates are raising such a potential for harm to the public that regulatory action is necessary.

The regulator is concerned with potential for harm. He need not wait for the tombstone count to get so large that the existence of a problem is statistically demonstrable. Regulated groups usually argue, when opposing proposed regulatory action, that the absence of tombstones shows that there is no problem. The regulator must firmly reject any effort to limit his regulatory action to areas of statistically demonstrable need. He must retain the right to use judgment, based on probabilities and reasonably credible accidents, in deciding whether there is a problem.

The regulator should not issue regulations in anticipation of irresponsible conduct on the part of those whom he regulates. There are enough actual problems to strain the meager governmental resources devoted to regulatory matters. The regulator should devote his resources to tangible problems, not amorphous possibilities.

4. REGULATORY FUNCTIONS

Beginning in 1893 with the first safety appliance act for railroads (27 Stat. 531), Congress has passed a series of laws which provide for federal regulation of safety standards for all modes of transportation. The air and water modes and highway commercial carriers have long been regulated; automobiles, pipelines, and (with minor exceptions) railroads have been subjected to regulation only recently. The various statutes creating these authorities differ in both form and content, reflecting the differences in the modes of transportation, the relative political strength of those covered by each statute, and the social climate at the time of creation.

Though Congress has written a variety of special provisions into the different transportation safety programs, these functions are (explicitly or implicitly) common to all:

Information. The regulator has to have information as to the need for regulatory action and as to the kind of regulatory action which is needed, else his decisions will be guesswork. Accident and incident reports are the principal sources of information from the public, supplemented and verified by the agency's own field inspections. The regulator should require these reports in enough detail for him to determine the kind and number of accidents which are happening in the activities subject to this authority, the cause or causes of these accidents, and the damage to the public resulting from the accidents.

Regulation. The regulator's prime function is to issue standards for the conduct of industrial activities. The standards should provide the highest degree of protection for the public, within the limits of technical feasibility and economic practicability. Regulatory agencies have different names for their standards, such as regulations, standards, orders, notices, and permits. Congress has been equally imprecise in the use of these words in delegating authority. Regulation is the term generally used to denote a standard of general applicability.

Education. The regulator has to make sure that his regulatory requirements are known to every affected person. Knowledge is requisite to compliance.

Surveillance. After publishing regulations, the agency spot checks regulated activities to find whether those subject to the regulations are complying with the requirements and to determine whether the regulations are adequate to protect the public. While most people voluntarily comply with regulations, surveillance enhances the disposition to comply.

Enforcement. Legal enforcement action is the regulator's ultimate step in getting compliance with his regulations. The type and extent of enforcement depends largely on the disposition to voluntary compliance on the part of those subject to the regulations. The purpose of enforcement is to get compliance; enforcement is not an end in itself.

B. ORGANIZATIONAL RELATIONSHIPS

5. THE REGULATOR AND CONGRESS

Congress creates a regulatory agency to perform a delegated function, because Congress does not have the capacity to do the kind of detailed work and marshal the kind of specialized knowledge which is required to administer a particularized program. Then individual members of Congress frequently get involved in the details of administering the program.

Congress, acting through the responsible committees, has a continuing responsibility for over seeing the performance of the functions which it has delegated. Individual members of Congress do not have any responsibility for the performance of these delegated functions and do not have even colorable authority to dictate specific regulatory action. The regulator is solely responsible for his regulatory acts; he cannot share responsibility for his acts, nor can he share blame for his failures, with any member of Congress.

Congress determines the need for a regulatory program, creates the regulatory agency, delegates authority to the regulator, determines the policies and procedural safeguards under which the regulator will exercise his authority, funds the agency's activities, and maintains a continuing oversight of the agency's performance of its function. The regulator performs the functions which Congress has delegated, to the extent that they can be performed with the resources which Congress has provided. These roles are schematically distinct and independent, but the regulator learns early in his career that some members of Congress neither honor the distinction nor respect the regulator's independence.

Members of Congress frequently criticize regulatory standards upon the happening of a headline event and demand that the regulator take some sort of regulatory action immediately. Notwithstanding the self-evident fact that these comments and demands are usually based on minimal knowledge of either the regulations or the facts surrounding the event, they sometimes send the whole agency into a funk. This inordinate sensitivity to off-the-cuff Congressional comment reflects on the professionalism and the leadership of the agency. Many regulators respond to this stimulus with a flurry of band-aid activity, a palliative for Congressional concern instead of a solution for a problem.

Band-aid activity is inherently bad government. It wastes agency resources, contributing less to the safety program than the same amount of effort would have contributed in a non-panic atmosphere. Congressional oversight committees can make band-aid activity unattractive to the regulator by inquiring into the long-range validity of such quick-response actions. Systematic inquiry into the overall conduct of his program by the committee to which he regularly reports is a more effective stimulus to the regulator than sporadic demands for specific action by an individual member. Orderly procedures may not make headlines, but they make good government.

A proponent of a regulatory proposal will sometimes ask a member of Congress to intercede for him with the regulator, usually after the proponent has been unsuccessful in getting favorable action through normal regulatory channels. In some instances, usually on the basis of information furnished by the proponent, the Congressman will ask the regulator to act favorably on the proposal. From the Congressman's point of view, the request is in order, because a proponent can always couch a proposal in legitimate public-interest terms. But the proposal may be only nominally related to achieving the stated purpose; in fact, it may be designed to give the proponent a competitive advantage by requiring or authorizing the use of a device which he has but his competitors do not have.

As a matter of courtesy, the regulator should promptly review the merits of any proposal from a member of Congress. Assuming that the proposal is without merit, what weight should the regulator give to the Congressman's request for favorable action? A Congressman's request for favorable action does not lend merit to a proposal which would not have merit without the request. The regulator should not let an *ad hominem* argument influence his judgment as to the merits of the proposal. No individual member of Congress has the right to speak on any matter on behalf of the whole Congress. The regulator acts on behalf of all of Congress when he exercises his delegated authority. It would be an affront to Congress as a whole for the regulator to let an individual member influence his judgment.

Few Congressmen will arbitrarily press for regulatory action after learning of the lack of merit in a proposal. For that reason, if he cannot act favorably on a recommendation, the regulator should promptly explain to the Congressman why a recommendation cannot be honored. Even if the Congressman should persist, the regulator must exercise his own objective judgment. He owes that to the Congress, the public, the regulated industry, his agency, and himself.

6. THE REGULATOR AND THE NATIONAL TRANSPORTAITON SAFETY BOARD

The National Transportation Safety Board is in the Department of Transportation, but it is not under the operational control of the Secretary. The Board has authority to investigate accidents, make safety studies, and make recommendations to prevent transportation accidents and promote transportation safety. These activities are directed at the safety programs administered by the regulatory agencies of the Department: Federal Aviation Administration, United States Coast Guard, Federal Highway Administration, Federal Railroad Administration, National Highway Traffic Safety Administration, and Office of Pipeline Safety. These agencies do not like the Board's independent appraisal of their safety programs; their inherent dislike is compounded by the legal requirement that the Board make public its accident investigation reports, safety studies, and recommendations. Predictably, the agencies are less than candid in their dealings with the Board.

Regulatory agencies in the Department of Transportation should give the National Transportation Safety Board complete access to all information which may be pertinent to the Board's functions.

Congress created the National Transportation Safety Board in 1967 to monitor the safety programs administered by the Department of Transportation. Although not under his operational control, the Board serves a quasi-staff function for the Secretary by reviewing and reporting to him the quality of administration of these programs and recommending improvements. Thus the Secretary has the benefit of an additional appraisal staff, if he chooses to view the Board's activities in that light.

All of the Board's authority was newly created in 1967, except authority over aviation safety which was transferred from the Civil Aeronautics Board. By continuing the authority over aviation safety, Congress reaffirmed the need for an independent entity to make a continuing appraisal of the Federal Aviation Administration's safety program. By creating equivalent authority over safety in other modes of transportation, Congress recognized a similar need for independent appraisal of their safety programs. Congress has amply evidenced its concern and clearly stated the Board's authority.

Regulatory agencies often tend to engage in treadmill activities, to be preoccupied with procedures, to value conformity over innovation. And the tendency usually increases with the size and age of the agency. Fortunately, it is only a tendency and can be corrected, if the agency sees the posture into which it is slumping. Unfortunately, no man can look over his own shoulder and appraise his own performance. The function of the Board is to look over the agency's shoulder, alerting the agency to the shortcomings of its program and preventing the tendency from stifling the program. To perform this function, the Board must have access to all pertinent information within the Department.

The Board has a mission and it will perform that mission-well or ill, depending largely upon the kind and quality of information available to it. While good information will not ensure good Board performance, poor information will almost certainly lead to poor performance, particularly ill-founded recommendations. Perhaps nothing is harder for a government official to live with than the ill-founded recommendations of other government officials. This is especially true when the other government officials have been authorized by Congress to make recommendations. In their own self-interest, the regulatory agencies should furnish the Board full information.

7. THE REGULATOR AND THE REGULATED

The regulatory agency and the regulated are in constant contact, covering the whole range of regulatory activities. Their communications are frequently oral; to the extent that these communications influence regulatory action, the record of the reasons for regulatory action is incomplete. The agency usually does not make available to the general public the information acquired in these private exchanges with the regulated. The general public does not have comparable contact with the agency. Many agencies discourage public participation in their regulatory programs; few encourage it.

All communications between the regulatory agency and those subject to its jurisdiction should be available for inspection by the general public-not only as a matter of legal right, but as a matter of philosophic bent. To prevent development of a cloistral relationship between regulator and regulated, the regulator should bring public participants into the regulatory processes and use their knowledge in examining the validity of representations made by the regulated. The regulator and his staff should avoid any relationship with the regulated which would compromise their freedom of action.

The regulatory agency should communicate with the regulated in writing and encourage the regulated to communicate in writing. The agency should summarize in writing any oral communications which it may receive and then treat the summary as it would treat a written communication. Written communications minimize misunderstandings, make information available to all members of the staff in readily usable form, and provide a full and accurate account of the factual basis upon which regulatory action was taken.

Persons subject to regulation often ask that they be permitted to make off-the-record comments about regulatory proposals. Neither the regulator nor any member of his staff should listen to any persons presentation, briefing, or argument on any regulatory proposal, unless that person is willing to have his comments put in writing and subjected to public examination. The regulator plays the patsy when he bases regulatory action on off-the-record information (except that which is required by statute to be withheld from public disclosure). The regulator needs all the help he can get in examining and determining the validity of information. The process is difficult enough with all information exposed to public view; secrecy makes it impossible.

Those subject to regulation seek out the regulator and his staff and keep them informed of all information and events which are favorable to the wishes of the regulated. There is little comparable presentation of information and events which are unfavorable to the regulated. Regulations are best developed in proceedings which test the validity of all representations, through use of diverse sources of fact and expert opinion. The regulator should, through a semi-independent segment of his own staff or through outside consultants, examine the validity of representations and develop alternate positions. To do this, he must have independent sources of information and expertise. The regulator can develop these sources by getting the active participation of such non-regulated groups as labor unions, scientific societies, consumer groups, and other government agencies.

It's a rare day when someone whom he regulates doesn't tell the regulator that he doesn't have to worry about some problem, that "we'll take care of it, because we're as interested in safety as anybody." When he hears this, the regulator must remember that the public is more interested. Congress made that determination in the first place when it established the agency, because the unregulated activity was not producing an acceptable level of safety. And Congress reaffirms the determination every year when it appropriates money for the agency. However great the regulated industry's interest in safety-and the

8. THE REGUALTOR AND OTHER PUBLIC AGENCIES

Many states, municipalities, and other public agencies base their laws and regulations on federal standards. This poses a problem when the federal regulations are changed.

Federal regulatory authorities should not forego needed regulatory action, even though inconvenience may result to other governmental agencies. Federal regulatory authorities should involve other governmental agencies early in the federal rulemaking procedures, so that they will have time to make such changes as may be required in their own laws and regulations.

To illustrate the problem, assume that federal regulations for interstate shipment and a state regulation for intrastate shipments both require a safety relief device for cylinders charged with zyn, a compressed gas. Then assume that a study shows that the hazard to the public is less when zyn is shipped without a safety relief device. If the federal regulation were changed and the state regulation were not, a wholesaler receiving an interstate shipment would not be able to deliver it to retailers within the state.

For another illustration, assume that (for some reason lost in antiquity) federal regulations classify chlorine as a compressed gas. Then assume that a toll road authority permits a truck with a "Compressed Gas" placard to use its facilities, but prohibits a truck with a "Poison Gas" placard. Then assume that a study shows that chlorine should be classified as a poison gas, which would require a "Poison Gas" placard. If the federal regulation were changed and the toll road regulations were not, trucks carrying chlorine would no longer be permitted on the toll road, even though the hazard on the toll road would not be different because of changing the placard. The "Poison Gas" placard does not create a hazard, it only warns the public of the existence of a hazard.

Regulated groups frequently oppose proposed federal regulation for fear that a change in federal requirements will result in some problem with state or local government agencies. Federal regulators should disregard this argument. The federal regulations protect the whole public, whole non-federal regulations protect only some segment of the public. When there is a conflict between the needs of the whole public and some lesser segment of the public, the needs of the whole public must be met.

The federal regulator should take into account the need for consistent regulations by all levels of government. Industry cannot serve the public when it is subject to conflicting laws. The federal regulator should keep other government agencies apprised of his plans and projects, so that they may know in advance that federal regulations may be changed. Then he should provide a long enough lead time, between adoption of a regulation and the time it becomes effective, for nonfederal agencies to make necessary regulatory changes.

The federal regulator must adopt the regulations which are needed for the protection of all the people. He cannot fail to act, even when his action inconveniences other agencies or those who must comply with the new requirement. He should minimize the inconvenience through coordination, but he cannot fail to act.

9. THE REGULATOR AND THE PUBLIC

Most regulatory agencies do no more than the law requires in involving the general public in the regulatory processes, but actively seek the participation of those who are subject to regulation. Many agencies are reluctant to make information freely available to the public, though they usually are willing to share information with those whom they regulate. There are statutory prohibitions on revealing some kinds of information (e.g., trade secrets), but agency practice usually is more restrictive than the law requires.

The regulatory agency should actively seek public participation, early and often, in the regulatory processes. The public should have access to all information in the possession of the agency, excepting only the work papers and in-house memos of the agency staff. Information which should be freely available to the public includes accident reports, investigation reports, correspondence, and memos of formal and informal meetings. The Freedom of Information Act (5 U.S.C. 55) requires that much of this information be made available upon formal request. The agency should make it all freely available, except that which is prohibited by statute.

Regulatory agencies perform a public function. That function can best be performed in full view of the public. Except where the national security is involved, there is no reason for a capable and honest regulatory official to be secretive about his actions and the reasons for his actions. The only regulatory officials who need hide behind secrecy are the incompetents who hide their blunders, the malefactors who hide their wrongdoings, and the timid or lazy who would rather deal privately with the regulated than wrestle with conflicting information and contending forces in open regulatory procedures. Until the day that regulations are developed in open procedures in full view of the public, the public will be fully justified in questioning whether it is well served.

Those subject to regulation frequently ask regulatory agencies to withhold information from the public. Since regulated groups publicize the favorable information, only the unfavorable information is withheld from the public-and from those who review the agency's actions. Remembering that the regulator is charged with protecting the public, should the dealings between regulator and regulated be kept secret from the public? What are the motives of the person who contends that the public is not entitled to know all that the regulatory agency and the regulated groups know about each other? Only when it has that information will the public be confident that its agencies are serving its needs.

Participation of the general public contributes to the validity of regulatory processes. In fact, the regulator cannot claim a valid program unless the public does participate. The regulatory staff will undoubtedly prefer to deal only with regulated groups, because "that's where the knowledge is; besides, they understand the problem." Participation of regulated groups in the regulatory processes is not altruistic. On the contrary, it is palpably self-serving, as it should be. The agency functionary who thinks otherwise misleads himself. Information furnished by the regulated will be useful in the regulatory processes only to the extent that it is examined and verified by sources which are non-regulated. These non-regulated sources are in the general public. It behooves the regulator, in his own self-interest, to seek all the knowledge and advice he can get-and to require his staff to develop it for him.

C. ORGANIZATION AND ADMINISTRATION

10. THE REGULATORY STAFF

The regulatory staff develops the notices of proposed rule making and the regulations which the regulator issues. The quality of the regulatory program depends in large part on the quality of the staff work. Sometimes a regulator, running jet age programs with bronze age techniques, will issue a regulation on the basis of "experience and judgment" or some equally amorphous substitute for legitimate staff study.

The staff should submit a notice of proposed rule making to the regulator with a staff study which recites the facts which define the problem, states the problem, develops alternative solutions for the problem with an analysis of the effectiveness and the technical feasibility and economic practicability of each alternative, and recommends the preferred solution with the reasons why this solution is better than the other alternatives. When the staff submits a final regulation for signature, the study should summarize and evaluate the public comment received in response to the notice of proposed rule making and show how the public comment was taken into account in developing the final regulation. These considerations should be summarized in the preamble which accompanies the notice of proposed rule making or the regulation.

The regulator reviews the staff study to determine whether he should issue the notice or the regulation. When considering issuance of a regulation, he also reads the public comment on the notice and checks whether the staff has taken public comment into account in developing the regulation. Remembering that the regulator performs a delegated legislative function when he issues a regulation, the staff should make a proper legislative record. The preamble to the regulation is analogous to a legislative committee report; it states the reason for, and the effect of, the regulation. The public docket is analogous to the whole legislative history; it contains all the information upon which the regulator relied in issuing the regulation. The staff must see that the public docket (information freely available to the public, in whatever form it may be kept by the agency) contains all this information, so that the whole basis for his action will be public.

Why do regulators sometimes accept and act on inadequate staff work? In some cases, this may be due to the lack of enough staff to do a thorough job. Since a prime function of a regulatory agency is issuing regulations, this may show an improvident allocation of manpower. But the principal reason seems to be the regulator's lack of confidence in himself, his staff, or both. By relying on "experience and judgment" the regulator is on safe ground, because he and his staff profess more experience and judgment in his specialty than anyone who might review his programs. Further, experience and judgment cannot be quantified and analyzed by anyone reviewing his programs and seeking to determine the validity of the regulations. Stating the facts and giving the reasons for his actions would make it easy for others to check his performance, so his lack of confidence leads the regulator to evade review-at the price of a bungled program.

The regulator will get away with bungling as long as he is permitted to get away with the "experience and judgment" dodge. Those who evaluate a regulatory action should be able to look at the staff study and find whether the regulator requires his staff to know the sources of information, accumulate all pertinent information, and use the information in a logical way in defining the problem and devising a regulatory solution, particularly in exploring alternatives.

The object of adequate staff work is to assure valid regulatory action, not to nail the regulator for his mistakes. But human nature being what it is, a system for spotting mistakes is a major factor in preventing mistakes. The regulator should require proper staff work from his subordinates, so that he may check the validity of their recommendations and thus be sure that he takes informed action. Higher executive authority and Congress should require the regulator to state-publicly and fully-the reasons for his regulatory actions, so that they may check the validity of his performance.

Another reason the regulator should require his staff to do good staff work is that it will prevent them from blindly perpetuating the errors and inadequacies of the past. The experience part of the "experience and judgment" syndrome encompasses the errors and inadequacies of the past. They will continue to be a part of that experience until consciously questioned. There is no need to reinvent the wheel every time a wheelbarrow is designed, but there is need to examine the design components closely enough to raise a question as to the efficacy of a square wheel.

12. ACCIDENT AND INCIDENT REPORTS

Most regulations are based on semi-informed guesses. The regulator do not know the number and kind of accidents within their areas of responsibility, the causes-not the superficial, but the actual and controllable causes-of accidents, and the damage to the public resulting from those accidents.

The regulator should have an accident and incident reporting system which requires those subject to regulation to provide enough information about what has happened to permit the agency to project what may reasonably happen. For an agency concerned with transportation safety, the system should be designed so that the regulator can determine:

- The number and kind of accidents which are occurring in the activity subject to regulation;
- The number of persons killed and the number seriously injured in these accidents;
- The amount of property damage resulting from these accidents;
- The manner in which accidents result in death, personal injury, or property damage;
- The cause or causes of these accidents; and
- The relationship, if any, between each of the various causes of accidents and the kind and severity of the resulting injury to person or property.

The regulator must make a number of critical decisions in the process of identifying controllable causes of accidents, defining safety problems, determining priorities among problems, and developing optimum cost/benefit solutions for priority problems. As in all decisional processes, the regulator's decisions are no better than the information upon which they are based. Good decisions depend upon good information. The regulator may draw upon many sources of information, but all other sources combined are not as important as detailed accident information. The regulator should require the regulated to report 1) each accident which results in unacceptable harm to the public, such as death, serious personal injury, and significant property damage and 2) each incident which is statistically significant, although it does not result in harm to person or property. The reports should be on a standard form so that the information will be suitable for automatic processing.

Accidents result from recurrent causes, some controllable and some not, with statistically determinable frequency. The recurrence of death, personal injury, and property damage also can be determined statistically. If the regulator had complete information about all prior accidents, he would be able to make a projection of the statistical probability of future accidents, their causes, and resulting injury to the public. But most agencies have neither complete information nor systems for gathering information. Their rudimentary accident reporting systems seem designed to gather information about the damage resulting from the accident-deaths, personal injury, and property damage-rather than about the cause of the accident. Information about resulting damage may enable the agency to answer inquiries about today's headlines, but it will not help the agency to prevent tomorrow's headlines.

An accident reporting system will enable the regulator to identify problems, determine which problems need priority attention, and allocate resources to priority projects. Without statistical analysis as a basis for setting priorities, the regulator has to rely on guesswork, influenced by the latest headline. Until he has enough statistical information to give him confidence in his priorities, confidence based on a

13. DELEGATING AUTHORITY

Many regulators sign regulations without knowing anything about the particular regulation, maybe without even knowledge of the general subject being regulated. They sign in reliance on staff advice, accepting staff initials on the paper's edge in lieu of personal knowledge of the paper's contents.

The regulator should not sign a regulation unless he is personally convinced that the regulation is valid. The head of an agency should delegate signature authority to subordinate officials to the extent necessary to ensure that each part of the agency's regulatory function is performed by someone who has the time personally and knowledgeably to perform it.

The head of an agency is responsible for all agency acts, but this does not require him personally to perform each act. The first principle in management is that the head of an organization can best do his job by parceling out the organization's functions among his subordinates and then supervising their performance. This principle applies as well to regulatory agencies as to other organizations. And it applies as well to the issuance of regulations as to other agency functions.

Sometimes the head of the agency signs all regulations because he believes that protocol requires his signature, that somehow his signature lends weight to the regulation, even though he hasn't the vaguest notion as to the validity of what he is signing. Or maybe the head of the agency has a personality problem and needs to feed his ego by wielding his pen and making law. Whatever his motive, the regulator is play acting when he signs a regulation without personal conviction that the regulation is valid. And the conviction must come from the regulator's own intellectual effort, not from reliance on an encrustment of staff initials.

Good management practice requires the head of the agency to delegate to others those regulatory functions which he does not have time to perform personally. The delegation should go far enough down in the organization that the person signing a regulation will have been able to:

- Monitor accident and incident reports to identify emerging safety problems;
- Supervise the staff as it develops a regulatory project, first making sure that the problem is properly defined and then that all reasonable alternative solutions are considered;
- Study the public comments, received in response to the notice of proposed rule making, and make sure the staff takes the comment into account in the staff study; and
- Determine that the optimum solution to the problem is the regulation which he signs.

If the agency is of any size at all, the head of the agency should probably delegate all signature authority, since he would not have time to perform any of it personally.

"How can I trust my subordinate with the responsibility for making laws?" With this rhetorical question, the head of an agency explains his retention of signature authority. The question advances an argument which is based on an unsound premise, because he does-in all practical effect-trust his subordinates to make laws. When the head of an agency signs a regulation without personal conviction as to its validity, the signing is an act of trust. He has trusted a subordinate to determine the need for, and the contents of, a regulation, but he has not made the subordinate responsible for it. The person who performs a function should be responsible for it; in a regulatory function, responsibility is in the person who has signature authority. Thus the real question is, how can the head of an agency trust a subordinate to perform a regulatory function without making him responsible for the performance? It is conceptually wrong for the signature on a regulation to represent no more than the signer's blind faith in his staff. The signature should signify personal responsibility for the regulation.

In addition to fixing responsibility for issuance, delegation of signature authority eases the subsequent review, which the head of the agency must make from time to time. The person who signs a regulation has some degree of commitment to it, even a person who knows nothing about it except that it was issued over his signature. And he will have a defensive attitude about it, if its validity is challenged. The head of an agency must review all aspects of agency performance, including the individual regulations. He should not prejudice his overall review by making piecemeal commitments to individual parts of the program, particularly when the commitments are not knowledgeably made.

D. DEVELOPING REGULATIONS

14. ADOPTING INDUSTRY STANDARDS AS REGULATIONS

Many regulatory agencies, some openly and without apparent shame, adopt industry standards as their safety regulations.

The regulator should develop his own regulations to solve the problems which he has defined; he should not adopt industry standards as regulations.

As used in this chapter, "industry" includes all industrial companies which are engaged in activities closely enough related to be covered by an industry standard. An industry standard is a collection of recommendations, written by a non-government group, covering such things as specifications for making and maintaining hardware, training and qualifying workmen, and operating procedures.

Standard-writing committees, usually sponsored by professional societies, are composed of representatives from industry, suppliers of goods and services to industry, and a variety of non-industry sources such as college faculties, research institutions, non-profit foundations, and government agencies. The professional societies and non-industry participants object to having their work product described as an industry standard. Their objection is valid in the literal sense of the terms, but the usage is appropriate in this chapter to point up the facts that industry has a major voice in developing the standard, the standard is developed for the benefit of industry, and industry has the ability tactically to prevent adoption of any recommendation which it does not want included in the standard.

Industry standards are usually specific how-to-do-it documents, based on yesterday's technology and techniques. Based on the cumulative knowledge and experience of experts in industry and related fields, they advise industrial companies on accepted ways of performing their activities today. They do not purport to accommodate tomorrow's technology and techniques. However, since they are only advisory, the individual companies are free to experiment with new ways of doing things. When the experts on an industry standard-writing committee are satisfied that experience has shown the worth of a new way, they will then incorporate it into the standard. Thus the industry standard recognizes and recommends that which experience has shown to be good, while permitting experiment and innovation.

Consider what happens when the regulator adopts such an industry standard as a regulation. That which was designed as a recommendation becomes a legal requirement. Anything new or different will have to be accommodated by some sort of special permission. By limiting the regulated companies' ingenuity and initiative in developing new technology and techniques, a regulator probably does a disservice to both safety and economy when he adopts an industry standard as a regulation. An example of the stultifying effect of this kind of regulation is found in the limitations which municipal building codes put on innovations by the construction industry.

Assuming the regulator hasn't the capacity to develop his own regulations, should he then adopt industry standards? Does adoption of an industry standard as a regulation contribute more to safety than no regulation at all? Possibly so, but the benefit is unacceptably marginal. The regulator's adoption of an industry standard will require regulated companies, which might not otherwise voluntarily comply, to meet the standards which the preponderance of experts in industry and related fields have agreed upon. This is the only benefit, but not the only effect.

When the regulator adopts an industry standard as a regulation, the regulation may have the anomalous effect of shielding regulated companies from liability to the public. To illustrate, assume that a chemical company ships a poisonous liquid in 5-gallon containers made of 24-gauge steel sheet, complying in all respects with a written standard. Then assume that one of the containers is punctured in the normal course of transportation on a truck, the truck driver dies as a result of getting a few drops of the liquid on his skin while unloading the shipment, and the heirs of the truck driver bring an action for damages against the chemical company. If the shipment were made under an industry standard, compliance with the standard would not be a defense for the chemical company, because the court would inquire whether the company was negligent in using such a thin-skinned container for such a dangerous product. But if the shipment were made under a regulation, compliance with the standard probably would be a defense for the chemical company, because the court would not inquire whether the company was negligent in using a container which the regulation authorized for that poison. Thus, when the regulator adopted the industry standard as a regulation, he gave the regulated company a defense against the consequences of its own acts.

The regulator misapprehends his role when he treats government regulation as an extension of industry self-regulation. In a well-conceived regulatory scheme, the demarcation between government regulation and industry standard would be clear. The regulations should prescribe what industry must do by stating, so far as possible, the level of performance which it must meet, leaving industry free to develop the specific means of meeting the prescribed level of performance. Regulations should prescribe what; industry standards should describe how. When the regulator understands his role and states the requirements in terms of performance standards, government regulations and industry standards serve distinct and complementary purposes. To the extent that the regulator misapprehends his role and states the requirements in specifics, the distinction is blurred-with the inevitable result that the regulator will start adopting industry standards as his regulations.

Industry standards are developed by knowledgeable people who contribute their time and talent to this useful community purpose. When not conceived as embryonic regulations, these standards can serve a number of good purposes. In many instances, they have produced an acceptable level of safety, so that there is no need for government regulation. There is no question that most industries have more detailed knowledge and experience than the regulatory agency. This talent should complement the agency's regulatory effort, not supplant it.

15. REGULATORY OFFICIALS IN NON-GOVERNMENT GROUPS

Officials of regulatory agencies frequently participate as members of non-government groups which are concerned with the processes by which regulations are developed, adopted, and enforced. When a regulatory official participates in such a group, he frequently finds himself in the paradoxical position of having to take action as a government official on a recommendation which he helped a non-government group to develop.

An official of a regulatory agency should not be a member of any group which has non-government members, if the group:

- Participates in developing any proposal which may later be considered by regulatory agency;
- Participates in rulemaking processes by formally commenting on notices of proposed rule making or informally reviewing drafts of regulatory papers; or
- Develops industry standards for complying with regulatory requirements.

Although the participants are both industry and non-industry, these groups should be thought of as "industry" groups for the same reason "industry" standards was appropriate in the preceding chapter, to reflect the extent and vigor of industry participation. Any long-established group with both industry and non-industry members is apt to reflect industry views. Industry participants have the talent and incentive to take the dominant role in any non-government group which deals with the regulations to which their companies are subject. And if industry participants do not get the dominant role, their self-interest will lead them to quit the group. A company does not profit by subsidizing participation in a volunteer group unless the group's efforts serve the company's purpose.

Industry participants seem to have no trouble understanding that the group draws its strength from the participants and that each participant surrenders some of his independence to the group. Unfortunately, many regulatory officials do not seem to grasp the group/member relationship, to realize that their participation lends the prestige of their offices to the group's recommendations, to perceive the group ethic which requires a compromise of independence as a condition of participation. If a regulatory official does not understand the dynamics of group action, he is ill-prepared to participate in group activities; if he does understand, he is ill-advised to participate.

Assume that the regulator personally participates as a member of the industry group, opposing some and favoring other of the proposals which the group later recommends to him for regulatory action. What can the regulator do about a recommendation with which he disagreed during group discussion? He knows the appreciable differences in purpose and procedures between the industry group and his agency. In its decisional processes the industry group was not subject to the procedural safeguards prescribed for regulatory actions; the public did not participate in the group's decision making; the public has no right of access to the group's files and deliberations as a means of evaluating the recommendation or examining the group's motives; and the group is not accountable to any public authority. What should the regulator do with a recommendation out of this background? On the one hand, he cannot in good conscience take an action which he personally believes to be wrong. On the other hand, he may lose credibility as a member of the group, if he rejects in his sole role as regulator a proposal which he could not defeat in argument as a member of the group.

The regulator cannot even take comfort in acting favorably on a group recommendation with which he agreed during group discussion. He cannot be proud of committing himself to a position at a preliminary step in the regulatory process. The regulator cannot properly commit himself until he has gotten all the information which is available from all sources. Once he has committed himself, he will tend to seek only those facts which buttress his position and his staff will be dissuaded from a vigorous search for other information and points of view. This is more apt to be so when the regulator has stated his position as an advocate in an argumentative situation. To avoid commitment or appearance of commitment, the regulator should never express an opinion on a pending regulatory matter, even for the sake of argument, until the time for definitive action. His staff members may enjoy the luxury of commitment and argument, but not the regulator.

If the regulator is a passive member of the group, "just sitting in to get a feel for the problem" as it is usually described, his participation is still against public interest. He is subjected to round after round of industry argument, without the safeguard of hearing opposing views. Some regulators probably delude themselves that they are too strong-willed to be influenced in this way. Maybe so, but those who believe that should ask themselves why industry groups persistently try to get them involved.

Assume that the agency participant in an industry group is not the regulator, but a member of his staff. To whom does the regulator turn for independent advice? And he would certainly need independent advice, because staff participation in industry group decision making is subject to the same vices as is the regulator's participation. Perhaps he should ask a different member of his staff to advise him. But which is more competent, the one he sent to the industry group or the one he later asked to advise him? If he sends the more competent to the industry group, he cannot rely on the advice of the less competent. If he sends the less competent to the industry group, that representative will soon lose credibility with the group, because the group will find out that he is being second-guessed by a more respected employee. From any point of view, staff participation in industry groups militates against credible staff work. When the regulator lets his staff participate in industry group activity, he compromises the staff's worth to himself. As he looks at each staff study, he will wonder about its validity. Is this independent staff work, or does it reflect the group's discussions? Is his staff loyal to him and his policies, or does that loyalty run-even in part-to the group? The regulator will always know that the group has influenced the staff study, but he will never know how much.

There is no quieter, more genteel, less troublesome way to run a regulatory program than to act favorably on industry group recommendations. Because the path is easy, the regulator must guard against dominance, while maintaining communication. Industry influence is pervasive in any event, but it can be kept in perspective. The regulator must have the information and advice which industry can give to his program, but he should keep his relationship with the regulated industry on a par with his relationship with other sources of information and advice. He should never demean his office nor exalt industry's position by being a first-person participant with the regulated industry in developing regulations. In the regulator's lexicon, "we" must mean the regulator and the public, not the regulated industry.

16. NOTICE OF PROPOSED RULE MAKING

In the Administrative Procedure Act (now 5 U.S.C. 553) Congress prescribed general procedural safeguards for the administration of regulatory programs. The most important safeguard in safety programs is the notice of proposed rule making, which gives interested persons an opportunity to comment on the proposed regulation. The regulator must take the comments into account when issuing a regulation. Congress has not prescribed the detailed content of the notice. In most safety agencies the regulator signs the notice as well as the regulation. Some agencies submit a draft of a proposed notice for preliminary comment to those who will be subject to the proposed regulation, before issuing the notice of comment by the general public.

The regulator should delegate to one or more subordinates the authority to sign notices of proposed rule making. The notice should be issued early enough in the rulemaking process for the comments to play an affirmative part in shaping the final rule. The notice should never be submitted to the regulated before it is issued to the general public. As a minimum, each notice should:

- Define the problem which the proposal is designed to solve;
- Discuss alternative solutions which have been considered, comparing the technical feasibility and economic practicability of the alternatives; and
- Propose to adopt one of the alternatives as a regulation, with a discussion of the reason for choosing that alternative; or the notice may propose adoption of either of two alternatives which appear to be equally acceptable and ask for comment as to the relative merits of the alternatives.

The notice advises the public that the agency proposes to issue a regulation and asks the public to participate in the rulemaking by commenting on the proposed regulation. The notice does not commit the agency in any manner, except to study the public comment and then take such action as the regulator considers appropriate. That action might be to issue the regulation as proposed; issue a regulation which differs from the proposal, but is still within the scope of the notice; issue a new or amended notice, changing the proposal; issue a part of the proposed regulation, withdrawing the balance or issuing a new notice as to the balance; or withdraw the proposal. The agency should take final action promptly after getting public comment-within a few months at most. It is an adverse reflection on the agency when it delays the solution of a defined problem, after it has received all available information through public comment.

Since Congress has not prescribed in detail the content of the notice, a bare recital of the proposed regulatory language might meet the legal requirement, but it would not inform the public or stimulate much comment. Fortunately, most notices explain why the agency is making the proposal, but in many cases the explanation reads more like a sales pitch for the proposal than an invitation to comment on it. A notice should consist of a preamble, the text of the proposed regulation, and an invitation to interested persons to comment on the proposal. The format for the text of the regulation and the invitation to comment are rather cut and dried; the merit of the notice is in the preamble. The preamble should fully and candidly explain the background of the proposal (outlined above), admit any doubts as to the adequacy and validity of information, and point out any areas in which public comment would be particularly helpful. To realize on the potential of the notice, the preamble has to show the public that the agency wants help and then move the public to offer help. The potential for help is in the public, but it takes a good preamble to realize on that potential.

The notice must reach the public in order to generate comment. The only legal requirement for distribution is publication in the Federal Register, hardly a publication of general circulation. The agency has to distribute the notice by other means in order to get a response. The best means is to develop a mailing list of potential commenters and distribute the notice directly to them. The size of the list is limited only by the ingenuity of the agency staff in developing correspondents. The list will not serve its full purpose until it reaches all sources of information, including industry trade associations, labor unions, individual regulated companies, scientific and technical societies, universities, other government agencies, and knowledgeable individuals.

The public needs time to comment on the notice. There is a tendency on the part of many agencies to give the public only 30 days for comment. Although the agency may have spent a year or two developing the notice, there is too often an unseemly haste to get the comment phase over with. The comment period should be at least 60 days for even the most routine notice, longer for more complex notices. Since the purpose is to get public participation, the time for participation should not be so short as to discourage it.

The most common argument against publishing evocative notices is that "it would be foolish to waste time developing all the stuff for the notice." This argument assumes that a notice can be issued on less information than that outlined above; that assumption is not valid. If the person who issues the notice has acted rationally, rather than intuitively, he will not have to do any additional work for the purpose of the notice. He will only have to tell the public of the steps he took in deciding to publish the notice. The request for comment should at least advise the public of the considerations which underlie the notice. The staff imposes on the public when it asks for comment on a proposed regulation while withholding information which would make that comment informative and worthwhile. The staff does a disservice to the regulator when it fails to develop information and worthwhile public comment.

The agency would issue the notice at an intermediate point in the decisional process. Of course, a tentative decision has to be made before there is any basis for issuing a notice, but the notice must be issued while the staff attitude is still flexible enough to make affirmative use of the public comment. If the decisional process has gotten beyond the tentative stage, there will be a predisposition to reject information which does not support the proposal. Over a period of time, this will discourage public participation and cut off a valuable source of information.

An agency should never submit a draft of a notice to a regulated group for comment before issuing the notice for comment by the general public. The agency and the regulated must freely exchange information and views at all times, but there is a distinct difference between exchanging information and views and giving the regulated a prepublication opportunity to censor a notice. The purpose of the notice is to give everyone, including the regulated, an opportunity to comment on the proposal. The public will quickly lose confidence in an agency which caters to the regulated by offering for public comment only those notices which have the prior blessing of the regulated. The agency must have both the capacity and the courage to publish notices and regulations without seeking the prior blessing of those whom it regulates. The lack of either capacity or courage foredooms the agency's failure as a protector of the public.

Many agencies discourage public comment, preferring "informal coordination with knowledgeable people," their euphemism for negotiation with those whom they regulate. Why doesn't a regulatory staff encourage public participation in regulatory processes? Maybe the staff doesn't want the file to show conflicting information and points of view, because the staff might then have to make some hard decisions, maybe even some decision which would be unpalatable to the "knowledgeable people." Maybe the staff has not gone through the bothersome process of defining the problem, developing alternative regulatory solutions, and making technical feasibility and economic practicability studies. Or maybe the regulator has somehow let the staff know that he prefers to act on intuition (masquerading as experience and judgment) and horsetrading with the regulated industry.

The notice should be signed by someone on the regulator's staff, rather than by the regulator himself. The notice is not a final decision; it is a request for help in making a final decision. The regulator should avoid even the appearance of commitment to the proposal at the notice stage, so that his final decision will not be prejudiced. The public will more readily accept the notice as a tentative decision and will be more interested in commenting on the notice, if the tentative nature of the notice is emphasized by having the notice signed by someone of lower rank than the one who will make the final decision.

Commenters frequently suggest that the regulator take some action which is beyond the scope of the notice. These suggestions should not be dismissed as gratuitous comments. Rather, they should be treated as petitions for rulemaking. Further, the preamble to the final action should acknowledge receipt and explain how the suggestions will be handled.

17. TECHNICAL FEASIBILITY

Regulators often propose, and sometimes adopt, regulations which require equipment or techniques which are not available or human skills which are not in adequate supply. Conversely, they may adopt regulations which are less effective than they should be, because they do not require use of the best hardware and procedures which can be developed.

The regulator should be a leader in his area of responsibility, keeping abreast of current technology and encouraging the development of ever-better hardware and procedures to raise the level of performance by those subject to his regulation. After identifying a problem, the regulator should require his staff to seek the widest possible participation in determining the technical aspects of the problem and developing a solution. The regulator should consider as technically feasible those things which can be developed with reasonable diligence.

Regulatory agencies are far from omniscient. They need all the help they can get on all aspects of their programs, including the technical features of problem definition and solution. The agency gets this help through means as varied as it has the gumption (and sometimes the budget) to devise. Few regulatory staff men err on the side of boldness in their search for technical knowledge, some because they cannot cope with documented information and differing views, and others because "there's no need to sweat it now that the regulated industry has given us this well-documented study which shows that there's really only one way to do it anyway." The regulator is entitled to better than that from his staff.

Whatever problem it may be considering, the agency can count on the regulated industry for help-information, studies, recommended solutions-in developing regulations. The general public is not so aggressive in sharing its knowledge, because the individual members of the public do not have the incentive. But there is technical knowledge in the general public, knowledge which the agency must seek out. To evaluate this input of information, the agency must have independent technical competence, both people and research facilities, though not necessarily in permanent employees and separate agency laboratories. Until the regulator identifies a continuing need for a particular kind of detailed knowledge, he should content himself with a permanent staff of technical generalists and have the detailed work done by consultants and contractors. Other government agencies are a good source of objective advice.

In determining what is technically feasible, in both hardware and human skills, the regulator is not limited to off-the-shelf hardware, historically proven procedures, and already-existing human skills. When the public welfare requires it, he can require industries under his jurisdiction to enlarge the horizons of knowledge and develop hardware, procedures, and human skills which are reasonably attainable. Those things are reasonably attainable which can be developed with reasonable diligence. The determination of the degree of diligence which is reasonable depends on the severity of the threat of harm to the public. The greater the threat of potential harm to the public, the higher the degree of diligence which the regulator may reasonably require of the regulated industries to minimize the threat to the public.

A regulated industry will need time to comply with any regulation which requires new or different equipment, procedures, or skills. The length of time will depend upon the availability of the new or different requirements, off-the-shelf items usually requiring less time than those which must be developed. A too short lead time requires a crash program for compliance, which may result in inferior products at unnecessarily high cost. Over the long haul, the regulator's program is usually better served by giving enough time for compliance so that the regulated industry can comply in an orderly fashion. In setting the time for compliance, the regulator should not rely on the representations of the regulated industry; he should also consult with those who will supply the goods and services to the regulated industry. Once he has set what he believes to be a reasonable time for compliance, the regulator should not extend it without good cause. If the regulator gets a reputation for extending the time for compliance, the industries which he regulates will be less than diligent in meeting future compliance dates.

18. ECONOMIC PRACTICABILITY

Regulators usually do not make a cost/benefit analysis of regulatory proposals, probably because they do not develop cost and benefit data. Because "money cannot be a factor when human life is at stake," regulators may hide their heads in the sand and fail to develop a factual record regarding the cost of proposed regulations. But they regularly and imprecisely take cost into account obliquely, because "it would take a pot of money to do that much training" or "that sure would take a lot of new equipment." Like the ostrich, the regulator exposes his most unattractive feature when he sticks his head in the sand.

Cost is a limiting factor-in fact, the principal limiting factor-in any regulatory program. The regulator should openly and honestly take cost into account in setting regulatory standards. He should make a cost/benefit analysis of each proposed regulatory solution to a problem, despite the fact that he will frequently be comparing dollar costs with non-dollar benefits. The analysis is particularly helpful in choosing the best solution among alternatives.

To ensure the legitimacy of regulations, the various elements of the developmental process must be legitimate. To this end, the regulator must legitimize the discussion of cost and subject every proposed regulation to an informed cost/benefit analysis. Without a cost study, based on verified information, the cost factor cannot be known and the analysis degenerates into guesswork, particularly since informally submitted and unverified cost figures from the regulated industry must perforce be used if nothing better is available. The public is entitled to better government than that.

Cost is usually stated in dollar terms, but time may also be a cost factor. For example, the speedometer on a car and the speed limit on a highway are both safety requirements and both represent a cost factor, one in money (the out-of-pocket price of the speedometer) and the other in time (the loss in productivity resulting from lower speed). Time as a cost is harder to compute than direct money cost, but it is no less real and should be computed. Has anyone ever computed the difference in cost between the 65 mph speed limit on the limited-access highways in Virginia and the 75 mph speed limit in Tennessee? And the difference in benefit? If not, we have an example of governmental guesswork.

Difficult as it is to compute the cost of a regulatory proposal, it is child's play compared to the computation of benefit. What is the value of a human life, when computing the projected benefit of a safety regulation? What is the benefit of lesser spills of petroleum products on navigable waters? What is the value of marine life saved from destruction? What of truly intangibles, such as esthetics? But the benefits must be computed. Admitting the difficulty of equating dollar cost and non-dollar benefit, the regulator must make a cost/benefit analysis, else his regulations will rest on guesswork. The regulator will find the analysis invaluable in choosing between alternative solutions for a problem.

In considering a proposed regulation, most people seem to think of the added cost of compliance as a net cost to the regulated industry. They do not consider the benefits which will result from the requirement. Accidents cost money; when there are fewer accidents, the cost of operations is less. The projected cost of a regulation should be reduced by the projected savings which will result. On a cost/benefit basis, the savings may be considered as either a decrease in cost or an increase in benefit. But it must be taken into account and will be taken into account when the staff routinely makes a cost/benefit analysis.

To illustrate, consider the cost of railroad accidents. The Federal Railroad Administrator told a Congressional committee in 1969 that railroad accidents were increasing at an annual rate of about 10% and that the cost of these accidents had exceeded $258,000,000 in 1967. As the Federal Railroad Administrator develops safety regulations to reduce the number of accidents and minimize the damage resulting from each accident, he has this substantial cost of unsafety to offset the cost of his safety requirements. Further, the cost of unsafety is an annual figure, available on an accrual basis to offset the cost of complying with safety requirements which may be one-time expenses.

In all industries, the cost of unsafety is high, but it is not known with any useful degree of accuracy. An agency's accident and incident reporting system should require each year a statement of the cost of unsafety by the companies subject to its regulation. The cost of unsafety for this purpose includes the losses resulting from all accidents which could have been prevented or mitigated by an exercise of the governmental power delegated to the regulator. Until he knows the cost of unsafety, the regulator will not have a part of the information necessary for a cost/benefit analysis of subsequent regulatory proposals. The regulator has to continually improve the accident reporting system until his figures on the cost of unsafety are so well articulated that he can calculate the cost of unsafety in relation to the particular problem with which the proposal is concerned.

19. GENERAL STANDARDS OR SPECIAL PERMITS

Some regulations require regulated companies to get specific agency approval for each item of equipment and each operating procedure used in regulated activities. These regulations usually give little guidance as to what the agency will approve and seldom set standards for approval. Other regulations are so narrowly drawn or stated in such specific language that regulated companies have to seek special permission for new or different activities.

Regulations should set general standards for the conduct of regulated activities, but should not prescribe detailed means of performing the activities. The regulations should be stated broadly enough to cover the full range of activities which the regulator deems to be in need of regulation. The regulations should not require a regulated company to get agency approval before using any equipment or changing any procedure.

This scene is repeated all too often, in all too many regulator's offices: There is this problem-not yet defined, but identified by newspaper headlines and Congressional comment...They're demanding action, so we must act...Never mind that we don't know what to do, we've got to do something...All right, lets require each regulated company to get our specific approval for equipment and procedures used in the problem area. The scene ends in activity without action, the hard-pressed regulator's tried-and-true dodge. He doesn't know what needs to be done and he hasn't the vaguest notion as to what he may approve when a regulated company proposes something, but never mind-it'll take the heat off today.

This bit of gamesmanship gets the agency off the hook temporarily-and it's harmless. Harmless? This seemingly innocuous regulation has an unseemly potential for mischief, a potential which will almost surely be realized. When a regulation requires prior approval of something, but does not set a standard for giving approval, it is the subsequent approval of the specific matter which actually sets the standard of conduct. Far from being innocuous, this regulation sets the stage for perversions of regulatory authority and evasions of the administrative procedures which Congress established to guard the integrity of the regulatory processes.

Agency approval of equipment and procedures gives the seal of government approval to the use of the equipment and procedures in regulated activities. No one can challenge the fitness of the equipment or the propriety of the procedures, except by filing a petition for rule making with the agency. If a regulated company, using approved equipment and procedures, injures an innocent bystander, the company can use the seal of approval as a shield against the injured person's claim for damages. In this event, the regulator will not have used his authority to protect the public, as Congress intended; rather, he will have used his authority to protect the regulated company. This perversion of regulatory purpose is discussed in Chapter 14, Adopting Industry Standards as Regulations.

Individual agency approvals of equipment and procedures are negotiated privately between agency employees and regulated companies, without public participation. This is an evasion of the procedural requirement that regulations (remember that the actual regulatory requirement is set in the individual approval) be issued only after notice of proposed rule making and opportunity for public participation. The lack of public participation means that action is taken on less than complete and validated information, since the applicant surely will not volunteer information adverse to his application. Further, since the approval authority is generally delegated to employees of considerably lower rank than the regulator, the practical effect of a series of approvals is that regulatory standards are set by employees who do not have the kind of staff support available to the regulator.

When regulations require prior approval but do not set standards for giving approval, the agency may publish in-house instructions to employees. The agency usually develops these instructions in consultation with industry, but without public participation. To the extent that these instructions set standards for giving approval, they have the effect of a regulation, so they should be adopted only after notice and opportunity for public comment. If he is to give approvals, the employee needs instructions, but the instructions should be published as regulations after notice and public comment. Better still, the regulator should publish regulations which set an adequate standard for the conduct of regulated activities, without reserving anything for private negotiation and approval. The regulator should be able to write better standards, with the help of his staff and the panoply of regulatory procedures, than one of his employees can negotiate in head-to-head bargaining with a regulated company.

Some regulations are written entirely in specifics, with every piece of equipment and every procedure individually prescribed. With this kind of regulation, the regulated companies must seek specific approval for each new or different activity, with all the vices noted above.

20. PERFORMANCE STANDARDS OR DETAILED SPECIFICATIONS

Most regulators state their requirements for equipment in terms of design and manufacturing specifications, rather than as performance standards. In many instances, specified pieces of equipment authorized to serve the same purpose have markedly different performance characteristics.

The regulator should set standards for equipment by prescribing first the performance standards which the equipment must meet and then the tests to which the equipment must be subjected to determine whether it meets the requirements. Performance standards consist of a quantified description of:

- The environment in which the equipment must be capable of operating, including those elements which would cause the equipment to deteriorate during the projected period of use;
- The functions which the equipment must be capable of performing and the projected period of use; and
- The integrity (strength and reliability) of the equipment, which will vary in relation to the degree of hazard to the public which would result from a failure of the equipment.

Tests consist of:

Exhaustive type tests, which may consist in part on engineering analysis, to determine whether the design concepts and manufacturing processes have produced a piece of equipment which meets the performance standards; and

Routine production tests to ensure that equipment coming off the production line meets type standards.

Design and manufacturing specifications usually are developed as industry standards and then adopted as regulations. They prescribe the materials, manufacturing processes, and quality control processes to be used in making the equipment. Regulators like to regulate by specification, because it is easy and precise-easy because it reflects yesterday's wisdom assembled and approved by the experts who establish industry standards; precise because it recites detailed descriptions of materials and manufacturing processes. But the regulator's assignment is to set the standards for tomorrow's activities, not memorialize yesterday's accomplishments. Despite the difficulty, the regulator should, wherever practicable, state his regulations in terms of performance standards, providing a regulatory milieu in which the public is protected while the regulated industry is free to innovate and make technological improvements.

Performance standards prescribe what a piece of equipment must be capable of doing after it is built, but not how to build it. The regulator must think in terms of performance, not processes. Thinking in terms of performance, the regulator tends to develop standards which will require that the equipment have the integrity to perform the function for which it is built. Thinking in terms of specifications, the regulator tends to tailor the standards for equipment so that the specified material of which the equipment is built can meet the standard.

Illustrations of this tendency are found throughout the hazardous materials regulations. Liquid poisons, some of which cause death when absorbed through the skin, may be shipped in a wide variety of containers, including steel barrels and drums, wooden barrels and kegs, and glass carboys in wooden boxes or plywood drums. Impact tests are prescribed for random samples of production runs of these containers to determine their integrity. These tests relate to the characteristics of the material of which the container is made, not to the need to contain the poisonous contents. Steel containers must pass the test without any leakage, but glass carboys in boxes or drums pass the test if no more than 10% shatter. The regulator unquestionably tailored this regulation to fit the material of which the container was made, rather than the function which the container was to perform; after all, he would look foolish if he prescribed for glass carboys a test which glass carboys could not pass. This is the almost inevitable result of dealing in specifics.

Special permissions, specifications, and performance standards are not mutually exclusive methods of writing regulations; all three may be used by the same agency at the same time in different parts of its regulations. Of these three methods of writing standards for equipment, only performance standards are a valid exercise of regulatory authority, when adopted under open regulatory processes which involve the general public early and often in the regulatory processes. Special permissions-any individual authorization, whatever name the agency may give it-are almost totally lacking in validity, since each permission is an approval of an industry proposal, an approval given without public participation and usually without standards to guide the person giving approval. Specifications have some validity, since they are adopted after notice and opportunity for public comment, but they are usually based on industry standards which were developed without public participation. Since regulation by specification lacks flexibility, all subsequent innovations lack validity, since the regulator has to issue special permission for each new or different piece of equipment or type of procedure.

E. SECURING COMPLIANCE

21. EDUCATION

Many agencies are not aggressive in educating regulated companies and their employees about the requirements which regulations impose on industrial activities. They seem content to issue their regulations and passively wait for the word to trickle down to the people who do the acts affected by the requirements.

The regulator should distribute his regulations, without cost, to all companies (and individuals, when the requirement applies directly to an individual who is not an employee of a regulated company) subject to his regulatory control. The regulator should require regulated companies to establish training programs which will ensure that each employee performing a regulated function knows what the regulations require of him and how to do his job so as to meet those requirements. The regulator should develop means of publicizing his regulations, so that everyone subject to his regulations will know the regulatory requirements.

As soon as he issues a regulation, setting a legal standard of conduct, the regulator turns his attention to getting compliance with the regulation. Issuance of a regulation does not raise the level of performance by those subject to the regulation. It only sets a legal requirement which, if complied with, would raise the level of performance. It is compliance with the regulation-performance according to the standard-which produces the desired result.

The agency cannot depend on spontaneous compliance. Education is the bridge between issuance and compliance. The agency has to develop an educational program which will ensure that those who perform regulated functions know what the regulations require of them. The first step is to distribute all regulations free of charge to all companies (and individuals, where appropriate) subject to the regulation, so that there is no doubt about their being advised as to the existence of the regulation. The second step is to require each regulated company to have a training program which will educate each employee, performing a regulated function, as to the requirements of the regulations to which he is subject and how to do his job to meet the requirements. The individual employee must know how to comply with the regulations, because he performs the function.

Of the many products of his office, regulations are the regulator's most important product. He should merchandise this product with a vigor equal to its importance, consciously using merchandising techniques in presenting each regulatory requirement to those affected by it. The agency should cultivate the trade press, trade association and labor union publications, and scientific and technical society journals, as means of getting the message to the people who need to know. The agency should also seek out opportunities to do missionary work at trade association and labor union conventions and at the one-week and two-week courses which universities offer to middle management.

Our social structure is built on voluntary compliance with the law, but compliance presupposes knowledge of the law. While everyone is presumed to know the law, the regulator cannot rely on this presumption in the administration of his program. Thousands of people in hundreds of companies are probably involved in the industrial operations affected by a new regulation. It is vacuous to think that they will somehow intuitively know of a new regulation when it is published in the Federal Register. The regulator's issuance of a regulation has no practical effect until the individual people who perform the affected industrial operations know what the regulation requires them to do.

22. SURVEILLANCE

Some agencies do not have inspectors to monitor the effect of their programs, particularly compliance with the regulations. Others have inspectors who do no more than investigate major accidents and prepare enforcement actions on any violations which may be found in the course of the accident investigation.

The agency should have a force of field inspectors large enough to monitor the regulated industry's activities under the regulations and advise the head of the agency as to the adequacy of the agency's efforts. The inspectors should monitor regulated activities to find whether the regulations are adequate, whether the education program is adequate, whether enforcement action is necessary to secure compliance, and to identify problem areas which need priority application of agency resources.

Regulations are not self executing, nor are they self correcting. A force of field inspectors is the agency's link with the regulated, advising the regulated as to the requirements of the regulations and advising the regulatory staff as to the efficacy of the requirements. Without adequate observation of industry practice under the regulations and the resulting level of performance, the agency must operate on guesswork, usually wasting resources by overreacting to newspaper headlines and Congressional comment. The inspectors are primarily concerned with securing compliance with the agency's regulations, of course, but they should also be charged with the responsibility for reporting on any adequacies or inequities which they find in the regulations. The regulations should be both adequate and equitable. The regulator should structure his whole operation to this end, particularly the points of contact with the regulated; no other part of his organization is as able to advise him on the practical effect of his regulations.

A good accident and incident reporting system is the cornerstone of surveillance, pointing the way to better routine surveillance and also indicating the need for special studies whenever there is a statistically significant bunching of events. Analysis of these reports shows the practices and procedures which result in accidents, pointing up the areas which the agency should monitor most closely and subject to special studies. Accident reports are a good means of identifying problem areas, but they should be verified on a sampling basis by on-site inspection by the field force.

The agency has to take care that its field inspectors do not lapse into a preoccupation with parochial concerns. Inspectors tend to think in terms of enforcement, because that is identified as a field function (a matter of group pride) and because they can quantify the results and document their work product (a matter of personal pride). Supervisors and employees alike want ways of demonstrating the results of their work-a laudable desire which the agency must take into account. The agency must structure the surveillance function so that results can be demonstrated by something more constructive than enforcement statistics. Enforcement is sterile, not creative, because it focuses on past errors, not on future performance. Some enforcement action is exemplary, of course, but each enforcement action is quite expensive in employee time, so the agency should be chary of time spent on legal actions. Since most agencies are limited in manpower, the agency should be careful to put its manpower where it will best serve the agency's overall purpose.

The best way to get the inspectors to work for the agency's overall mission is to provide him with incentives which relate to the overall concern. Every employee should have pride in his work and a means of measuring and demonstrating his accomplishments. Recognizing this, the agency must devise means of measuring accomplishments other than legal enforcement. This will require development of means of measuring accomplishment in terms of identification and definition of problems, improvements in the regulations, development of industry training programs, and other affirmative steps toward accomplishing the agency's overall mission.

23. ENFORCEMENT

Some agencies think it improper to adopt a regulation unless they have the manpower to mount an enforcement program which will ensure that regulated companies will comply with the requirement. Some agencies think that emphasis on legal enforcement is the way to get compliance with the regulations.

The regulator should adopt those regulations which are required to protect the public, without regard for his agency's ability to enforce the requirements. The agency should then seek compliance with the requirements through a variety of means, of which enforcement is but one.

Every regulator has some means of legally enforcing his regulations with either civil or criminal penalties, as provided in the legislation setting up the particular program. The vigor with which the agency enforces its regulations depends upon a number of variables which are not within the control of the agency, such as the disposition of the regulated industry voluntarily to comply with the regulations, economic stability of the industry (experience has shown that a prospering business is less apt to cut costs on regulatory requirements), the resources which Congress has given the agency for inspection and enforcement, and the disposition of the Department of Justice to take legal action at the request of the regulatory agency. Though the agency has a large measure of initiative, it does not have complete control over its enforcement program.

The agency protects the public by setting standards for the conduct of industrial activities and then getting regulated companies to comply with the standards. These functions are interrelated, but not interdependent. The regulator has an obligation to set the standards, even though Congress may have given the agency no manpower for enforcement. The regulator must recognize that his primary duty to set standards is separate from, and not dependent upon, his ability to enforce the standards.

Even though the agency does not have enforcement capacity, the public will benefit from the improved performance which results from voluntary compliance. Spokesmen for industry trade associations frequently argue that "you shouldn't impose this burden on the responsible members of the industry unless you have the manpower to enforce it against the irresponsible members, because that would put the responsible members at a competitive disadvantage." Parenthetically, these spokesmen are never willing to name the irresponsible members of the industry group. This argument is based on an unwarranted lack of confidence in the initiative of the American businessman. His self-interest will lead him to find a way to blow the whistle on a competitor who gains an advantage by violating the law.

The prospect of public liability resulting from failure to comply with a regulation is an important collateral enforcement device-probably more effective than the rather sterile and predictable agency enforcement, because it is more dynamic. If a regulated company fails to comply with a regulation designed to protect the public, and if a member of the public is injured as a result of the failure to comply, the company will be liable for the resulting damage. The prospect of liability for damages will be a greater incentive for compliance than the occasional slap on the wrist which is all the agency can do in legal enforcement. Insurance companies have an interest in compliance on the part of their insureds, as a matter of minimizing liability, so the agency should enlist the aid of the insurance companies in securing compliance.

After issuing a regulation, the agency is interested in compliance, not enforcement. Enforcement is a means, not an end in itself. Since most of the regulated industry will comply with most of those regulatory requirements with which they are acquainted, the agency's emphasis should be on education and surveillance, rather than enforcement. The agency's resources are probably misapplied if it spends as much as five percent of its inspectors' time on legal enforcement actions. But there is a need for regular and well-publicized enforcement action, as a club to get the attention of the mulish.

A WORD OF CAUTION TO THE CRITICS

A variety of official and unofficial agencies and individuals review and comment on regulatory programs. The comment is usually unfavorable, since few people bother to commend good work. And some fail to recognize it. In justice to the agencies, those who would criticize should first consider the inherent limits on a regulator's actions. This discussion relates directly to safety programs, but the principle should apply to all kinds of regulatory programs.

The regulator does not create abstract regulations in a social vacuum; rather, he seeks regulatory solutions to problems as they are seen in the light of the current social environment. Congress expects the regulator to perform his function in consonance with the general principles-admittedly ill-defined, but nonetheless real-under which other governmental social programs are conducted. In today's social environment, the regulator is expected to set safety standards which will keep the public as a whole free of unacceptable threat of harm; he is not required to protect every individual person from all possible harm.

Some level of harm to individual members is demonstrably acceptable to society as a whole. Congress did not act to establish safety standards for automobiles when the first preventable death occurred in an automobile accident. In fact, preventable casualties numbered hundreds of deaths and thousands of maimed bodies every week before Congress was moved to act. Millions of lives in this country are blighted by poverty, many to the extent of malnutrition and some to death by starvation, but we still have not committed the nation's resources to ending poverty.

Those who execute society's programs must recognize that the society they serve is not willing to spend its resources to ensure the safety and well-being of every individual member. Recognizing this, governmental programs are concerned with keeping the threat of harm to a level which is acceptable to society as a whole. The level of acceptability is determined in large part by contemplation (seldom legitimized by calculation) of the cost of reaching a higher level.

We emotionally profess to hold each human life beyond price, but our cost-limited social programs show the profession to be rhetoric-rhetoric which leads to unjust criticism of regulatory programs by those who fail to discern its emotional content. The regulator does not run an emotional program and should not be judged by emotional standards. He runs a governmental program and should be appraised by governmental standards.

APPENDIX D

OPS DOCKETS

Title 49—Transportation

Chapter 1—Hazardous Materials Regulations Board, Department of Transportation

[Docket No. OPS-3]

Part 190 – Interim Minimum Federal Safety Standards for the Transportation of Natural and Other Gas by Pipeline

Part 192 – Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

Establishment of Minimum Standards

This amendment establishes a new Part 192 in Title 49, Code of Federal Regulations, containing the minimum Federal safety standards for the transportation of gas and for pipeline facilities used for this transportation.

The Natural Gas Pipeline Safety Act was enacted on August 12, 1968. It required the Secretary of Transportation to adopt, within 3 months, the then existing State safety standards for gas pipelines as interim regulations and to establish, within 24 months minimum Federal safety standards. The interim standards were issued on November 7, 1968, as Part 190 of Title 49 of the Code of Federal Regulations and became effective on December 13, 1968. With the adoption of these minimum Federal standards in Part 192, the interim standards are no longer necessary. Therefore, the interim standards are revoked on the date that Part 192 becomes effective, except for those provisions applicable to design, installation, construction, initial inspection, and initial testing of new pipelines which will remain in effect until March 13, 1971.

These regulations were proposed in the following notices of proposed rulemaking issued between November 14, 1969, and June 10, 1970:

OPS Notice 69-3, 34 F.R. 18556.
OPS Notice 70-1, 35 F.R. 1112.
OPS Notice 70-2, 35 F.R. 3237.
OPS Notice 70-3, 35 FR. 4413.
OPS Notice 70-4, 35 F.R. 5012.
OPS notice 70-5, 35 F.R. 5482.
OPS Notice 70-6, 35 F.R. 5724.
OPS Notice 70-7, 35 F.R. 5713.
OPS Notice 70-11, 35 F.R. 9293.

This amendment does not include the requirements on corrosion control (Subpart I) which were proposed in a notice published in the FEDERAL REGISTER on May 6, 1970 (35 F.R. 2127). Final action on that notice will be taken after the comments that were received on the notice and at the public hearing that was held on July 20, 1970, have been analyzed.

Part 192 differs in many respects from the notices upon which it is based. Some changes were made for consistency in terminology and format. Others involve the moving of requirements from one section to another, or from one subpart to another, for better organization.

Many sections were renumbered, particularly in Subparts C, D, L and M. Even numbered sections and blocks of sections between subparts were left blank to accommodate additional sections in future rulemaking actions.

Some changes are substantive in nature and are based both on the comments received on the notices (over 500 separate comments totaling over 2,500 pages were received) and the recommendations of the Technical Pipeline Safety Standards Committee. Each of these changes is within the general scope of the notice on which it was based.

This is a major rulemaking action dealing with a highly technical subject in which many requirements are interdependent. Since the entire project was accomplished in less than 9 months from the first notice to the final rule, some of the changes may create problems in interpretation and compliance. Interested persons should inform the Office of Pipeline Safety in writing of any such problems, so that a determination can be made as to whether a correcting or clarifying amendment should be issued before the effective date of the particular requirement.

In addition to the many comments on the proposals which have been reflected in this final rule, a number of commenters recommended additional requirements to supplement present requirements or to cover areas not presently covered. Since many of these recommendations were beyond the scope of the proposed regulations, they could not be included in this final rule. However, these recommendations will be considered as petitions for rulemaking and many will be the subject of future rulemaking actions.

A large number of the comments were directed to areas of overall effect, such as the determination of maximum allowable operating pressure, the definition of "class location:, and the determination and effect of a change in class location. These general subjects are discussed in detail below. All other significant changes and comments are discussed in a subpart by subpart, section by section, analysis.

Determination of maximum allowable operating pressure. As proposed in the notice, maximum allowable operating pressure would have been limited to the lowest of a designated series of pressures. Two of the designated pressures were (1) the design pressure in the weakest element in the pipeline system, and (2) the pressure obtained by dividing the pressure to which the pipeline was tested after construction by the factor for the appropriate class location.

Since some pipelines have been operated above 72 percent of specified minimum yield strength (the highest design stress allowed by Part 192) and since many were tested to no more than 50 pounds above maximum allowable operating pressure, these proposed requirements would have required a reduction of operating pressure in those pipelines. In a letter to the Office of Pipeline Safety, the Federal Power Commission stated (NOTE: the section numbers are those used in the notice):

Section 192.617 establishes maximum allowable operating pressure for existing steel pipelines. Several limitations are listed with paragraph (a) providing, "No person may operate a steel or plastic pipeline or main at a pressure that exceeds the lowest of the following." Paragraph (a) (2) (11) is a table that requires applying a factor related to test pressure to establish the maximum allowable operating pressure. This table provides that in Class I locations the maximum allowable operating pressure cannot exceed the test pressure divided by 1.1 and in Class 2 locations a factor of 1.25.

Presumably these limits were established to relate to the requirements for testing presently contained in the Interim Federal Safety Standards which are essentially the same as those in ANSI B31.8-1968.

The proposed regulation does not recognize that the B31.8 Code did not establish these minimum test levels until 1952. Prior to that time, between 1935 and 1951, the predecessor Code, B31, required only that a pipeline be tested to a pressure 50 p.s.i.g. in excess of the proposed maximum operating pressure.

There are thousands of miles of jurisdictional interstate pipelines installed prior to 1952, in compliance with the then existing codes, which could not continue to operate at their present pressure levels and be in compliance with proposed section 192.617.

This Commission has reviewed the operating record of the interstate pipeline companies and has found no evidence that would indicate a material increase in safety would result from requiring wholesale reductions in the pressure of existing pipelines which have been proven capable of withstanding present operating pressures through actual operation.

If it is the intention of the Office of Pipeline Safety to require the retesting of all existing pipelines to the higher standards proposed in section 192.617, it is our suggestion that this section be revised to permit the development of an orderly testing program that will allow the jurisdictional pipeline companies the necessary time to obtain from this Commission such certificate authorizations as may be necessary.

In view of the statements made by the Federal Power Commission, and the fact that this Department does not now have enough information to determine that existing operating pressures are unsafe, a "grandfather" clause has been included in the final rule to permit continued operation of pipelines at the highest pressure to which the pipeline had been subjected during the 5 years preceding July 1, 1970.

The uprating requirements in Subpart K apply when an operator wants to establish a maximum allowable operating pressure higher than the highest actual operating pressure to which the pipeline was subjected in these 5 years. This will prevent an operator from using a theoretical maximum allowable operating pressure which may have been determined under some formula used 20, 30 or 40 years ago.

Changes in class location. The notice proposed that confirmation or revision of maximum allowable operating pressure, due to a change in class location, must be accomplished within 60 days of the date when the operator has notice that such a change has occurred. The notice requested specific comment on the proposed 60-day period, since the B31.8 Code provisions upon which this proposal was based did not contain a specific time limit. (It is relevant to note that the requirement for the evaluation of pipeline facilities when it appears that there has been a change in class location was newly adopted in the 1968 edition of the B31.8 Code, which does not apply in a number of States, and that there is diversity of opinion as to the burden these requirements impose on operators.) The comments on the proposed requirement were in general agreement that a 60-day time limit would be impractical and would leave the operators no alternative but to reduce pressure, thereby decreasing throughput. With respect to this proposal, the Federal Power Commission in its comments stated (note: the section numbers are those used in the notice):

Section 192.609(e) requires that, "confirmation or revision of the maximum allowable operating pressure in accordance with this section must be accomplished within 60 days of the date when the operator has noticed that a change in location class has occurred."

It is the Commission's opinion that this is an unduly restrictive requirement which would be impossible of accomplishment by jurisdictional interstate pipeline companies under the requirements of the Natural Gas Act.

Section 7(b) of the Act prohibits abandonment of facilities or any service rendered by such facilities without the permission of the Commission after due hearing.

Section 7(c) of the Act prohibits construction or extension of facilities unless there is in force a certificate of public convenience and necessity issued by the Commission authorizing such construction.

Giving consideration to requirements for public noticing opportunity for intervention and accumulation of an adequate record upon which a decision can be rendered, it does not appear that in every instance the Commission would have adequate time to permit alternate construction within the 60-day time limit.

The potential loss in delivery capacity at a time when many pipeline companies are encountering difficulty in obtaining adequate supply of gas to meet growth requirements could seriously affect the ability of the industry to meet its obligation to satisfactorily serve the public convenience and necessity of the Nation.

It is suggested that the Office of Pipeline Safety consider modifying proposed §192.609(e) to not be mandatory as applied to jurisdictional interstate pipeline companies unless and until appropriate certificate authorization has been granted by the Federal Power commission.

The alternative time periods suggested by the other commenters ranged from 120 days to 5 years. Further, the comments pointed out that compliance with this section would be complicated by the fact that the "class location" definitions were not identical with the present B31.8 definitions.

In view of these comments, the change in class location requirements will be treated in two phases. A new §192.607 contains requirements for the initial determination of class location and confirmation or establishment of maximum allowable operating pressure. Each operator is required to complete before April 15, 1971, a study to determine (for pipelines operated at more than 40 percent of SMYS) the present class location of all of the pipeline in its system, and whether the maximum allowable operating pressure for each segment of pipeline is commensurate with the present class location. The operator is then required to confirm or revise, in accordance with section 192.611, the maximum allowable operating pressure of the affected segment of pipeline so that at least 50 percent of the affected pipeline is confirmed or revised before January 1, 1972, and the remainder before January 1, 1973.

In view of the new definitions of "class location", the diversity of views as to how much time is needed for confirmation or revision of pressures after a change has been discovered, the fact that the change in class location requirements are not included in the interim Federal standards in a number of States, and the disagreement within the pipeline industry as to the actual meaning of the change in class location requirements added in the 1968 edition of the B31.8 Code, the impact of §192.607 will not be known until April 1971, When the required studies are completed. These studies may show that the existing pipelines are, for the most part, already in compliance with the new class locations, so that there will be little difficulty in meeting the schedule for adjusting operating pressure. On the other hand, the studies may reveal a problem of such magnitude as to raise serious question as the magnitude as to raise serious question as the practicality of the schedule.

The Office of Pipeline Safety plans to hold a public hearing in late April 1971 to get the results of the required studies and to give all interested parties an opportunity to present their recommendations on any adjustment which may be required in the schedule for adjusting operating pressures. The date, time, location, and other specific details of that hearing will be announced.

Sections 192.609 and 192.611 apply to changes in class location that occur after April 15, 1971. Under §192.611(e), an operator will have 1 year from the date when a change in class location has occurred to accomplish the confirmation or revision.

Odorization of gas in transmission lines. The notice of proposed rulemaking proposed to require the odorization of gas in transmission lines. This proposal was based on a requirement that presently exists in the States of California, New York, New Jersey, Massachusetts, and Vermont (previously Wisconsin was erroneously included in this list). Because the comments received on the original notice were almost unanimously opposed to the odorization of gas in high-pressure transmission lines, we issued a supplemental notice on June 10 requesting additional comments.

The comments received on the June 10 notice also generally opposed the proposal. However, the States of New York, New Jersey, and Massachusetts urged that the requirement be adopted as originally proposed. These States indicated that their experience with the odorization of transmission lines did not support the objections that had been listed in the supplemental notice.

The information on hand is conflicting and inconclusive, though it tends toward eliminating the requirement for odorization of gas in interstate transmission lines. Further, the comments were largely expressions of opinion, with little objective information to support the opinions. To insure that those who favor the requirement have ample opportunity to furnish further supporting information, the Office of Pipeline Safety plans to hold a public hearing in mid-September on this subject. The date, location, and other specific details on this public hearing will be announced in the near future. If warranted by the information received at that hearing, further, action will be taken before November 12, 1970, when Part 192 takes effect.

Liquefied petroleum gas systems. Section 192.11 contains requirements applicable to petroleum gas pipeline systems. The authority of this Department to regulate certain petroleum gas pipeline systems under the Natural Gas Pipeline Safety Act, has been questioned. Where there may be some question as to jurisdiction over a pipeline carrying petroleum gas from a tank (where it is stored in liquid form), to one or two single-family houses, there is no question as to authority over petroleum gas systems that serve, a significant number of customers. In these cases, there is certainly a sufficient affect on interstate commerce to sustain a Congressional grant of authority and the language of the natural Gas Pipeline Safety act is broad enough to cover such cases. Section 192.11 applies only to petroleum gas systems that serve more than 10 customers from a common source or in which a pipeline crosses a public place, such as a highway.

A new paragraph (c) has been added to make clear which gas systems have to meet the additional requirements of this section. In effect it excludes gas systems that use petroleum gas only to supplement natural gas supplies during peak shaving. The word liquefied has been deleted to avoid any implication that these sections apply to petroleum gas when it is in liquid form. Notwithstanding that §192.11 reflects the present requirements of the B31.8 Code, certain requirements (particularly in the operating and maintenance areas) may not be appropriate for a petroleum gas system. In order to determine whether there are any such inappropriate requirements and what, if any, changes should be made, we are asking operators of petroleum gas systems and other interested persons to comment on the various provisions of this regulation. If any of the provisions are inappropriate, commenters should suggest alternative requirements that would be appropriate and that would achieve the same safety objective.

Authority of States to act as enforcement agents of the Department with respect to interstate pipelines. In section 190.6 of the interim minimum Federal safety standards, States were authorized to act as the agents of this Department with respect to inspecting and overseeing interstate pipeline facilities, because the Office of Pipeline Safety was not staffed to enforce regulations. Termination of the interim regulations will not affect the authority of the States to act as agents of this Department with respect to interstate pipelines. The authority is being continued and those States that are already acting as agents of the Department may continue to do so without further indication of their intent. All existing agency relationships will continue until formally terminated by either the State or by this Department. Any State which wishes to act as agent, but did not previously so indicate, may establish an agency relationship merely by submitting a statement of intent to the Office of Pipelines Safety.

The agency authority with respect to interstate pipelines authorizes the State to maintain surveillance over the operation to insure compliance with Federal regulations. State personnel should perform the same function that Federal field personnel perform, inspecting operations and giving informal opinions and approvals as to compliance with the regulations.

The agency authority does not create enforcement authority in the State. Enforcement actions, except those which the operator voluntarily accepts, will be taken at the Federal level.

The agency authority does not authorize a State to create new standards or to take any action which would substantively change the Federal standards. The Act requires that standards be prescribed by the Department in accordance with applicable rulemaking procedures.

State and industry officials are invited to contact the Office of Pipeline Safety with regard to any questions that may arise concerning this relationship.

State and industry officials are invited to contact the Office of Pipeline Safety with regard to any questions that may arise concerning this relationship.

Effective date. As stated in Notice 70-1, section 3(c) of the Natural Gas Pipeline Safety Act requires that standards and amendments thereto prescribed under that Act "shall become effective 30 days after the date of issuance unless the Secretary, for good cause recited, determines an earlier or later effective date is required as result of the period reasonably necessary for compliance". In that notice, it was stated that since most of the proposed requirements would be based on existing recommended industry standards, a long lead time should not be necessary for compliance. Further, the notice requested commenters to identify specific requirements that would require a longer lead time.

In addition to the numerous comments received in the various dockets on the proposed effective date, the question of effective dates was discussed with the Technical Pipeline Safety Standards Committee. That Committee unanimously recommended that the overall effective date should be 90 days after the date of issuance. Additional time for certain provisions relating to new pipelines is covered in §192.13 and discussed elsewhere in this preamble. The primary reasons for an effective date more than 30 days after issuance are as follows:

1. Part 192 is a complete revision of the interim minimum Federal regulations and it is desirable to allow time for all affected parties to receive copies of the new regulation and to thoroughly review its provisions before its effective date.

2. Though Part 192 is based largely on the interim minimum Federal regulations, which were based primarily on recommended industry standards, we have found that many operators are not familiar

with the recommended standards of the B31.8 Code. From investigations of accidents and the comments on our notices of proposed rulemaking, we know that a wide range of operators – large and small, privately owned and municipally owned – are not familiar with either the Act or the interim regulations.

3. The B31.8 Code in many cases recommended the establishment of written plans, and the interim Federal regulations required plans, but the requirement was not stated in clearly mandatory terms. We now find many companies have not established the plans.

Therefore, after considering the comments, the recommendations of the Technical Pipeline Safety Standards Committee, and the other information that has come to our attention, the 90-day recommendation of the Technical Committee has been accepted.

Retroactive effect on existing pipelines. Many comments related to the effect of these regulations on existing pipelines. They expressed concern that existing pipelines would not meet the design, construction, and testing requirements of the new regulations and would therefore have to be replaced or otherwise modified in order to comply. There is no basis for this concern and the prospective effect of Part 192 is made clear in section 192.13. The Natural Gas Pipeline Safety Act [Section 3(b)] speaks quite clearly on this point, as follows:

Not later than 24 months after the enactment of this Act, and from time to time thereafter, the Secretary shall, by order, establish minimum Federal safety standards for the transportation of gas and pipeline facilities. Such standards may apply to the design, installation, inspection, testing, construction, extension, operation, replacement, and maintenance of pipeline facilities. Standards affecting the design, installation, construction, initial inspection, and initial testing shall not be applicable to pipeline facilities in existence on the date such standards are adopted.

Existing pipelines are subject to the maintenance, repair, and operations requirements. They may be subject to retest requirements or restrictions on operating pressure, under a future rulemaking action, if that action is necessary to meet the need for pipeline safety.

Federal regulations as a minimum standard. The scope provisions of these regulations state that they prescribe *minimum* safety standards. Though some commenters objected to the word "minimum" it has been retained. Under the Natural Gas Pipeline Safety Act, these are in fact minimum standards. With respect to interstate facilities under Federal jurisdiction: an operator may voluntarily exceed these standards. With respect to intrastate facilities under State jurisdiction, an operator may voluntarily exceed these standards. Further, section 3(b) of the Act specifically provides that a State agency may adopt additional or more stringent standards.

As evidence of hazardous situations becomes available the Department will, either through an individual hazardous condition order or through a general amendment, provide more stringent requirements for individual pipelines or for different types of pipelines.

Performance vs. specification requirements. As indicated in the series of notices upon which this regulation is based, we intend to state the Federal safety standards in performance terms, rather than as detailed specifications, whenever it is possible to do so within the state-of-the art and without lowering the required level of safety. Several commenters pointed out certain requirements that are stated in specification language and recommended that they be stated in the final rule in performance terms. As the discussion of this subject in the notices pointed out, the schedule within which this rulemaking action was accomplished did not give us time to develop adequate performance-type substitutes in all of the instances where such a standard would be appropriate. This is one of the areas to which future attention will be devoted and will be the subject of future rulemaking actions where performance-type requirements are appropriate.

Incorporation by reference. In the proposed rulemaking it was stated that, while the editions of the documents incorporated by reference in the notice were based on the B31.8 Code, the final regulation might be updated to incorporate the most recent edition of the referenced standard or specification. Specific comments were requested on whether the use of the newer editions would cause a significant change in the impact of the regulations involved. The comments in general indicated that use of the latest published edition would not create any problems. However, some commenters questioned how future edition changes would be handled, since pipe and materials built to a new specification could not be used if that specification were not referenced in the regulations. New editions of referenced documents will be reviewed as soon as they are available and, if found to be acceptable, will be included in the referenced documents.

Subpart A-General:
Section 192.3. In response to many requests, several new definitions have been added. A number of comments suggested the incorporation of all of the definitions in the B31.8 Code. This has not been done, since it is not necessary to define a term when it is used in its ordinary dictionary sense or in accordance with the meaning commonly understood in the industry.

We have defined those terms which are being used in a different sense than the commonly understood meaning. For example, the term "pipeline" is used in the B31.8 Code to refer to a high pressure, long distance transmission line, while in the Natural Gas Pipeline Safety Act the term is used as a generic term for all types of lines carrying gas in gathering, transmission, or distribution systems. Since this latter meaning is also consistent with the liquid pipeline regulation (49 CFR, Part 195), pipeline is defined in this broad sense in these regulations.

In most places where the proposed rules used the phrase "pipeline facilities," the word "pipeline" has been substituted. The terms "gathering line" "transmission line," and "distribution line" are defined as various types of pipelines. "Distribution line" is further divided into "main" and service line." In addition to these six terms, we have defined the term "pipe" to include tubing.

The definition of SMYS has been changed to make it consistent with the use of that term in the design formula of §192.105. For specifications listed in Appendix B, SMYS will be the yield strength specified as a minimum in the specification. For unlisted or unknown specifications, SMYS is the yield strength determined by tensile testing in accordance with §192.107(b) and Appendix B, paragraph II-D.

Section 192.5. A number of comments pointed out that the proposed class location definitions could create a 2-mile stretch of high-class location solely to protect a small cluster of buildings at a crossroad or road crossing.

To avoid this situation, a new paragraph (f) has been added to allow adjustment of class location boundaries. A Class 4 location boundary may be moved to within 220 yards of the nearest four-story building. Whenever a Class 2 or 3 location is required by a cluster of buildings in otherwise open country, the boundary may be moved to within 220 yards of the nearest building in the cluster.

In addition, a number of other changes have been made to clarify this section. It was pointed out by one commenter that heavy traffic and many other underground utilities almost always exist in an area where four-story buildings are prevalent thus making the proposed Class 4 location criteria redundant. Since other comments indicated some confusion about whether these requirements were cumulative or alternative in effect, the references to heavy traffic and other underground utilities have been deleted and the sole criterion for Class 4 locations will be a prevalence of four-story buildings.

The term "class location unit" has been substituted for the sliding mile, but will be used in the same way. It also has been made clear that each separate dwelling unit, such as an apartment, must be counted as a building intended for human occupancy.

Section 192.9. Several comments pointed out that, although gathering lines in nonrural areas were included in the scope, the proposed rules made no specific provision for them. This new section has been added to eliminate the problem by requiring all gathering lines, if they are subject to the regulations under §192.1, to meet the requirements applicable to transmission lines.

Section 192.13. This new section has been added to clearly state the applicability of these regulations with respect to new and existing pipelines, and to avoid confusion as to the retroactive effect of these standards. Due to the long lead times involved in preparing for pipeline construction, the new requirements for design, installation, construction, initial inspection, and initial testing will apply only to new pipelines that initially became ready for service after March 12, 1971. Since the comparable provisions of the interim standards will continue in effect until March 13, 1971, a pipeline that is readied for service before March 13, 1971, will have to comply with the interim Federal standards. With respect to existing pipelines, all changes made after November 12, 1970, must comply with Part 192.

A paragraph (c) has been included to make clear that plans, programs, and procedures required to be established must also be followed by the operators.

Section 192.15. Some basic rules to be used in construing these regulations have been set forth in this section.

Subpart B-Materials:
A number of commenters felt that failure to include certain types of materials would preclude their use. This is not the result because these regulations are not all-encompassing. Rather, they establish prohibitions and requirements only for those areas where safety problems are know to exist. To the extent that certain materials are not specifically treated, they need only meet the general requirements of this subpart to be qualified for use in a pipeline.

Section 192.53. This section has been reorganized slightly and, based on paragraph 810.1 of the B31.8 Code, a new requirement for chemical compatibility has been added. Since it is now used in other subparts as well, the definition of "listed specification" has been placed in §192.3.

Section 192.55. In paragraph (a) the word "or" was inadvertently omitted in the proposed rules. It has been inserted to make clear that paragraph (a) (1), (2), and (3) is complete alternatives, any one of which will suffice to qualify new steel pipe.

Several commenters apparently misunderstood the import of paragraph (c). This paragraph merely states the ways that new or used steel pipe may be used if it is not otherwise qualified under paragraph (a) or (b).

Section 192.61. This section has been expanded to require both new and used copper pipe to be manufactured in accordance with a listed specification.

Section 192.63. Several comments expressed concern that small diameter pipe is sometimes marked only by the bundle and therefore would not comply with this section. However, so long as marking by the bundle is prescribed in the manufacturing specification, the pipe will comply with this section under paragraph (a) (1). A paragraph has been added to prohibit field die stamping on surfaces of pipe or components that are subjected to internal stress.

Section 192.65. This section has been limited in application to large-diameter, thin-wall pipe which is more susceptible to damage during railroad transportation, if it is not properly loaded. Although the other pipe that would have been covered by the language of the proposed regulation might also be damaged by improper loading, this damage would be of a type that could be found by the required visual inspections and need not be a basis for rejecting the pipe as required by this section.

Subpart C-Pipe Design:
The proposed sections on corrosion factors and design limitations for steel pipe have been deleted and a new §192.103 has been added with general requirements for pipe design. These changes have resulted in renumbering of each section of this subpart after §192.101. The corrosion section is deleted, because we are now considering regulations which will require the installation of corrosion protection (proposed Subpart I) and control systems. Therefore, requiring an increase in the wall thickness of pipe to provide additional protection against the effects of corrosion will be unnecessary. The design limitations for steel pipe have been placed in § § 192.103 and 192.105(b).

Section 192.103. This new section has been added as a composite of several separate provisions contained in the design requirements for each type of pipe material. It replaces requirements proposed in the notice as § § 192.117(b), 192.119(b), 192.121(b), and 192.127(d).

Section 192.105. A sentence has been added to the definition of "t" to prevent the increase of design pressure based on wall thickness added under §192.103 to protect against external loads. Paragraph (b) was taken from the proposed design limitations on steel pipe without change. One comment suggested an alternative method of determining "S" for pipe of unlisted specification by hydrostatic yield testing. This suggestion appears to have merit but will require further study and a separate rulemaking proceeding to obtain the benefit of full public comment.

Section 192.111. In response to comments requesting clarification of this section, language has been inserted in paragraphs (b) (1), (b) (2), and (c) to insure that heavier wall pipe is installed across the entire right-of-way when a pipeline crosses a public road or street without a casing.

Since Class 3 and 4 locations require the use of design factors 0.50 and 0.40, the application of paragraph (d) has been limited to Class 1 and 2 locations.

Proposed paragraph (e) has been deleted. The situation it was designed for is now covered by §192.5(f) which permits adjustment of class location boundaries in thinly populated areas.

Section 192.113. ASTM specification A333 has been added to the longitudinal joint factor list. The flush paragraph at the end of the table has been reworded so as not to preclude the use of a lower joint factor if this is desired by the operator.

Section 192.115. In response to a comment, the word "gas" has been inserted in the table to make clear that this is a temperature attained during operation of the pipeline.

Section 192.121. The definition of "S" for thermosetting plastic pipe has been change to 11,000 p.s.i. to conform to the design provisions contained in the B31.8 Code.

Section 192.123. Paragraph (a) has been rearranged for greater clarity and a new paragraph, which was proposed as part of Subpart D, has been added.

Section 192.125. The minimum wall thickness requirement for copper service lines has been moved from Subpart H to this section.

Subpart D-Design of Pipeline Components:
This subpart has been completely renumbered and some sections have been combined or deleted to remove overlapping and redundant provisions. For instance, where there were 10 separate sections on compressor station design, there are now six sections; where there were six sections on pipe and bottle-type holders, there are now two sections. Most of this consolidation has been done without substantive change and, except for transfers to other subparts, the requirements that were proposed will be found in Subpart D. The substantive changes or transfers to other subparts are discussed below along with some of the more significant changes resulting from consolidation of proposed regulations.

Section 192.141. Reference to specific components or devices covered in Subpart D has been deleted from the Scope.

Section 192.145. Paragraph (a) has been rewritten to require that valves be used in accordance with the applicable API and MSS standards, rather than the service recommendation of the manufacturer, and that valves be capable of meeting "anticipated" operating conditions.

Paragraph (c) restricts the use of valves "having shell components made of ductile iron", whereas the proposed rule referred to valves "having pressure containing parts made of ductile iron". The substitution was made in response to comments that, as written, the rule would limit the use of valves with internal pressure containing parts, such as valve discs or plugs made of ductile iron. However, paragraph (d) retains the words "pressure containing parts made of ductile iron", since it was intended to limit such use in compressor stations where valves are subjected to greater vibration.

Section 192.147. Paragraph (a) is a new paragraph requiring that flanges and flange accessories meet the minimum requirements of applicable ANSI and MSS standards. Except for paragraph (c)(1), §192.144 as proposed in the notice and on which §192.147 is based has been eliminated in accordance with comments recommending that the section be rewritten in performance language, omitting details, and specifications.

Section 192.149. Paragraph (b), which requires that the actual bursting strength of steel butt-welding fittings must at least equal the computed bursting strength of pipe of the designated material and wall thickness, has been modified by the addition of the words, "as determined by a proto-type that was tested to at least the pressure required for the pipeline to which it is being added."

Section 192.151. This section entitled "Branch connections" as proposed in the notice as §192.146, is now entitled "Tapping". It now provides that a 1 ¼-inch tape may be made in a 4-inch cast iron or ductile iron pipe without reinforcement. However, in areas where climate, soil, and service conditions may create unusual external stresses on cast iron pipe, unreinforced taps may be used only on 6-inch or larger pipe.

Section 192.167. In response to a number of comments, electrical circuits needed to protect equipment, such as circuits driving the lubricating pumps, will not have to be deactivated by the emergency shutdown system. Since the requirements for shutdown systems for transmission and distribution compressor stations were so similar, they have been combined in paragraph (a) of this section.

Section 192.175. Since pipe-type holders are basically pieces of pipe, the requirements for their design and installation were nearly identical to those for pipe contained in other subparts. Therefore, the definition of pipe has been expanded to include these holders and all the identical provisions have been deleted. In addition, the prohibition against the storage of gas with a high hydrogen sulfide content in pipe-type and bottle-type holders has been transferred to Subpart L.

Section 192.179. The provisions on spacing of transmission line valves have been rewritten to more clearly express the intended result. Due to the lack of necessity and the impracticality of installation and operation, all offshore transmission lines have been exempted from the requirements for sectionalizing block valves.

Section 192.185. The requirement that vaults be located in accessible locations away from street intersections, heavy traffic, etc., has been modified by the addition of the words, "so far as practical". Many comments indicated that it would be impossible in some cases to comply with the section as written.

Section 192.189. The provision that "all electrical equipment in vaults must conform to the requirements of Class 1, Group D, of the National Electrical Code, ANSI Standard C1, has been modified by the insertion of the word "applicable" before the word "requirements".

Section 192.197. Paragraph (a) (5) has been rewritten in performance-type language by the addition of the words "to prevent a pressure which would cause the unsafe operation of any connected and properly adjusted gas utilization equipment."

Paragraph (c)(1) has been rewritten by changing "secondary regulator" to "upstream regulator" for purposes of clarity. A new subparagraph (4) has been added to the list of methods in paragraph (c) which may be used to regulate and limit the pressure of gas where the maximum actual operating pressure of the distribution system exceeds 60 p.s.i.g. This new subparagraph authorizes the use of –"A service regulator and an automatic shut-off device that closes upon a rise in pressure downstream from the regulator and remains closed until manually reset."

Section 192.199. A new paragraph (h) has been added to the requirements for pressure limiting or pressure relief devices. It provides that "except for a valve that will isolate the system under protection from its source of pressure, (such devices must) be designed to prevent unauthorized operation of any stop valve that will make the pressure relief valve or pressure limiting device inoperative."

Section 192.201. Paragraph (c) has been rewritten in performance-type language by deleting "2 p.s.i.g." and substituting "a pressure that will not exceed the safe operating pressure for any connected and properly adjusted gas utilization equipment."

Section 192.203. Paragraph (b) (6) is a new provision which requires that pipe or components subject to clogging from solids or deposits must have suitable connections for cleaning. Several comments pointed out that this requirement was contained in the B31.8 Code and should not be omitted from the regulations.

Subpart E-Welding of Steel in Pipelines:
Three of the sections that were in proposed Subpart E have been deleted or moved. Since each welding procedure contains detailed requirements for filler metal, it is not necessary to have a separate

requirement in these regulations. Section 192.213 now contains the restrictions on miter joints which were transferred from Subpart G. The section on the acceptability of welds has been added to §192.241 as paragraph (c). The section requiring repair of arc burns has been included in Subpart G with the section on repair of steel pipe.

Section 192.221. The words "arc and gas" have been deleted so as not to exclude new welding processes such as electron beam welding, from the scope of this subpart. In this section, as in other scope sections, the newly defined word "pipeline" has been substituted for "pipeline facilities." This will make it clear that these requirements do not apply to welding on water or air piping or welding during construction of buildings that will house gas equipment. Since the scope is broad enough to include all welding on pipelines and components, the words "when constructing, relocating, replacing, repairing, or otherwise changing . . . " are unnecessary and have been deleted.

Section 192.223. As proposed, paragraph (c) related to industrial safety practices; it has been deleted as inappropriate in these regulations. The size of a fillet weld is covered by individual welding procedures and a separate requirement proposed for paragraph (d) is repetitious and unnecessary. Paragraph (b) has been reworded to make clear that multiple qualification of welders under API 1104 is acceptable.

Sections 192.227 and 192.229. In response to a number of comments requesting clarification, these two sections have been reorganized. As proposed, §192.209 was intended only as an alternative method of qualifying for low stress level welders and did not preclude the use of high stress level welders on low stress level pipe. This section has been placed in §192.227 as paragraph (c) to clarify this point. Section 192.229 now contains only the limitations on the use of welders. The limitation in §192.229(c) has been added to cover the situation of the welder qualified for high stress level pipe [i.e., qualified under §192.227(a)] who welds only on low stress level pipe. High stress level welders are not required to periodically requalify since it is assumed that their work is regularly subjected to nondestructive testing. However, this is not always the case when they weld only on low stress level pipe, since nondestructive testing is not required for pipe to be operated below 20 percent of SMYS. Consequently, paragraph (c) requires high stress level welders to have at least one weld destructively or nondestructively tested each 6 months.

Since the guided bend test is appropriate only for butt welds and not for fillet welds, the requirement for compressor station welders has been made more flexible by requiring only that a welder's qualification be based on destructive testing, rather than requiring the specific test.

Section 192.233. Since miter bends are another form of welded joint, the restrictions on their use have been made more flexible by requiring only that a welder's qualification be based on destructive testing, rather than requiring the specific test.

Section 192.233. Since miter bends are another form of welded joint, the restrictions on their use have been moved from Subpart G to this section. The provisions have been reworded and the prohibition against miter bends in plastic pipe has been placed in Subpart F with the other provisions on the joining of plastic pipe.

Section 192.235. In response to many comments, paragraphs (c) and (d) have been deleted and paragraphs (a) and (b) have been combined. Since these requirements were appropriate for all welding, the section has been expanded and is no longer limited to butt welding.

Section 192.241. Paragraph (a) has been modified to avoid the implication that every weld must be inspected. This requirement is intended to impose on the operator the responsibility for providing sufficient visual inspection to ensure that certain criteria are met. In the case of a highly qualified and experienced welder, occasional spot checking may be sufficient to achieve this goal, while apprentice welders may require constant inspection.

Section 192.243. Several changes have been made to this section to remove or reduce some burdensome requirements that, in light of the comments received, would have provided little increased safety. There is a substantial increase in time spent and cost associated with testing the last few welds in order to achieve 100 percent coverage. Therefore, some flexibility is permitted in Classes 3 and 4 locations and at river crossings by permitting, if 100 percent testing is not practicable, the testing of less than 100 percent, but in no event less than 90 percent of the welds.

Also, since the identification and retention of X-ray film would present a substantial clerical burden, and will not prove too valuable in accident investigation, these requirements have been deleted from paragraph (f). Instead the operator will have to identify his testing records by geographic location to facilitate their analysis should leaks occur during subsequent testing or operation of the pipeline.

A third major change involves the applicability of paragraphs (d), (e), and (f). In order to encourage the use of nondestructive testing on the low stress level lines where it is not required, the provisions of these paragraphs have been changed so as to apply only to nondestructive testing that is required by §192.241(b). This will permit random testing of welds and welders on lines operated below a 20 percent stress level even though they are in a Class 3 or 4 location and will avoid the burden of keeping records in this situation.

Since the comments indicated that a single daily sampling of each welder's work is sufficient to establish his continued competency, the requirement for sampling to a specific percentage has been removed from paragraph (e).

An exception has also been made to avoid the problem of testing welders each day, who might be working in areas quite remote from the regular welding crew and testing apparatus.

The prohibition against the use of trepanning as a nondestructive testing method has been placed in paragraph (a) of this section.

Subpart F-Joinings of Materials Other Than By Welding:
Section 192.271. The scope of this subpart has been changed to make it clear that welding material other than steel is not covered. At such time as regulations to cover this subject are issued they will be placed in Subpart E. This change will also make it clear that joining of steel, other than by welding, is covered by this subpart. As with the scope of Subpart E, the broad coverage of this section permits the elimination of redundant language concerning constructing, replacing, and repairing of pipelines.

Section 192.273. The general requirement proposed for this section has been reworded to make clear that the use of restraint devices at points other than at the joints is permitted. So long as each joint will sustain the forces that may be applied, it does not matter whether the joint does so because of its own intrinsic strength or because of a restraining or anchoring device attached elsewhere on the pipeline.

In addition, two new requirements have been added to require visual inspection of the completed joints and the use of written procedures in joining. These new paragraphs are based on the general construction requirements of the B31.8 Code.

Section 192.275. As proposed, this section contained two requirements that related to existing joints in cast iron lines. To alleviate the misunderstandings that resulted from this placement and to put these requirements in their proper perspective, these requirements have been added to the subpart on maintenance as §192.753. As now written, paragraph (a) of this section applies only to newly joined caulked bell and spigot joints. The prohibition against brazing of cast iron pipe that has been added to this section was taken from a proposed requirement in Subpart H.

Section 192.281. Paragraph (a) has been rewritten in performance type language. The prohibition against miter joints in plastic pipe has been transferred to this section from Subpart G. The prohibitions against joining different types of plastic were too inflexible and have been deleted since the requirement for compatibility of materials that is contained in §192.53 attains the same objective.

Subpart G-General Construction Requirements for Transmission Lines and Mains:
Three proposed sections, 192.313-Dents, 192.319-Miter bends, and 192.329-Casing of plastic pipe or tubing, have been deleted or combined with other sections. Restrictions on dents are now included in the section on repair of steel pipe, §192.309. The restrictions on miter bends have been transferred to §192.233 of Subpart F. Paragraph (b) of the proposed section on casing of plastic pipe was deleted, since the design requirement in new §192.103, and the balance of the section on the casing of plastic pipe have been added to §192.325.

Section 192.301. Some comments suggested the establishment of separate sets of regulations for transmission lines and mains because of different operating conditions. However, the requirements are sufficiently similar to warrant retention in one set of regulations. If at some time in the future the requirements for transmission and distribution systems become sufficiently different, separate bodies of regulations may be established.

Section 192.309. The requirements for elimination of dents and arc burns have been added to this section as new paragraphs (b) and (c). In response to a number of comments, an alternative limitation has been established for the depth of a repair by grinding. If a piece of pipe has a greater nominal wall thickness than required for the pressure and stress level at which the pipe is to be operated, the operator may grind down the pipe wall to the required thickness even though the remaining wall may be less than permitted by the tolerances of the pipe specification.

Many commenters suggested that this section apply only to pipeline operated at 20 percent of SMYS, or more. In response to these comments, paragraph (a) has been changed to require repair only when the damage is such that the serviceability of the pipe is impaired. This will allow greater flexibility in repair of low stress level pipe, rather than requiring repair whenever a stress concentrator, however small, is discovered. With respect to dents, the specific requirements for removal contained in paragraph (b) will apply only to pipe operated at more than 20 percent of SMYS. Dents on lower stress level pipe will be subject to repair or removal under paragraph (a) if they impair the serviceability of the pipe.

Section 192.313. When this section was proposed in Notice 7-2, it applied only to steel pipe operated at 30 percent of SMYS or more. This limitation was based on a proposal originally made in Notice 69-3, the first notice of the series. It was intended to apply only to paragraph (a)(1) of the proposed section which required bends to be made at least one and one-half pipe diameters away from a circumferential weld. This restriction on bends has been deleted due to a number of comments questioning its validity and pointing out the problems this created when bending double-jointed pipe. Therefore, the 30 percent stress level limitation has been deleted as well. The new paragraph (a)(1) contains a broad, general requirement that a bend may not impair the serviceability of the pipe. Paragraph (a)(4) has been combined with paragraph (d) in a general requirement that applies to all types of pipe.

The restriction on out-of-roundness has been limited to pipe of more than 4 inches in diameter because the 2 ½ percent of nominal diameter is difficult to measure on small diameter pipe. In addition, it appears that greater degree of out-of-roundness is acceptable in small diameter, low-pressure pipe. Pipe that is four inches or smaller in diameter will be required to be serviceable as provided in paragraph (a)(1). Proposed paragraph (e) has been deleted.

Section 192.325. In response to a great many comments pointing out the difficulties that distribution companies would have attaining the proposed 12 inches of clearance, the clearance requirements for mains are now couched in performance type language. This will allow these operators flexibility to attain the desired objectives of proper maintenance and protection from external damage. In addition, a new paragraph has been added to refer to the section in Subpart D which prescribes clearance for pipe-type and bottle-type holders.

Section 192.327. The minimum depth of cover for transmission lines laid in consolidated rock has been decreased to 24 inches for pipe under drainage ditches and in Classes 2, 3 and 4 locations. After considering the comments it appears that a rock ditch with 24 inches of cover provides a considerable degree of protection, which is increased relatively little by requiring 30 or 36 inches of cover. However, despite the small increase in protection this additional 6 or 12 inches of cover adds substantially to the cost of construction.

It also appears that increasing the cover for mains from 24 to 30 inches will not provide nearly as much additional protection as had been hoped. Therefore the 24-inch requirement of the existing standards is being retained. However, we plan on developing new standards, particularly in the areas of marking, mapping, and interutility coordination of construction work, to achieve the additional protection.

The requirement for encasing or bridging a pipeline to protect from excessive external loads has been removed from this section since it is now covered by §192.103.

Subpart H-Customer Meters, Service Regulators and Service Lines:
Section 192.351. In accordance with suggestions received in the comments, reference to specific materials used for service lines has been deleted from the scope, and the words "customer's meters" have been changed to "customer meters" to avoid any implication of customer control over meters.

Section 192.353. The following changes, all of which were suggested in the comments, have been made in §192.353:

Paragraph (a) no longer requires that meters and service regulators be installed in a location that provides protection from corrosion or other damage", but only that they be installed in a readily accessible location, and "be protection from corrosion or other damage." The comments indicated that it is sometimes impossible for protection from corrosion and damage to be provided by the location itself. In addition, paragraph (a) now permits the upstream regulator in a series to be buried.

Paragraph (b) provides that each service regulator within a building must be located "as near as practical" to the point of service line entrance.

Paragraph (d) provides that "where feasible," the upstream regulator in a series must be located outside the building, "unless it is located in a separate metering or regulating building."

Section 192.357. Paragraph (b) of this section has been completely rewritten to express the intention that close all-thread nipples must be of extra strong wall pipe so that after the threads are cut, the remaining wall thickness meets the minimum wall thickness requirements of Part 192. Paragraph (d) was added to make clear that regulators that release gas must be vented to the outside atmosphere.

Section 192.359. This section has been rewritten to reflect the present practice of the industry, which based on the comments and further investigation, appears to be safe. Paragraph (a) limits the pressure at which any meter may be used to 67 percent of the manufacturer's shell test pressure.

Paragraph (b) requires that each new meter must have been tested by the manufacturer to a minimum of 10 p.s.i.g.

Section 192.361. In response to the comments, paragraph (b) no longer requires that each service line be "properly supported at all points" on undisturbed or well compacted soil but merely that it be "properly supported". Material for backfill must be "free of materials that could damage the pipe or its coating", rather than "free of rocks and building materials", as provided in the proposal.

Paragraph (d) now provides that service lines must be installed so as to minimize "anticipated" piping strain or external loading.

Section 192.363. The requirement for tamperproof valves in paragraph (c) is now limited to valves on high pressure service lines, installed above ground or in an area where the blowing of gas would be hazardous rather than all high pressure service lines, as in the proposal.

Section 192.365. Paragraph (b) requires that each service line be equipped with a shutoff valve in a readily accessible location that, "if feasible", is outside the building. This requirement applies not only to new shutoff valves, but also to replace valves and valves on replaced service lines.

Section 192.367. The requirement of paragraph (a) that a service line connection to a main must be located at the top of the main, or if that is not practical, at the side of the main, has been modified by the addition of the words "unless a suitable protective device is installed to minimize the possibility of dust and moisture being carried from the main into the service line."

Section 192.369. This section has been rewritten to require that a service line connection to a cast iron or ductile iron main must be made by a mechanical clamp, by drilling or tapping the main, or by another method meeting the requirements of §192.273. If a threaded tap is used, the requirements of §192.151 (b) and (c) must be met. Paragraph (c) of the proposal, which prohibited brazing a service line connection directly to a cast iron or ductile iron main, has been deleted from this section since it is covered in § § 192.275(d) and 192.277(c).

Section 192.371. The proposed requirement on installation of steel service lines in bores has been deleted and will be included in Subpart I on corrosion control.

Section 192.373. The prohibition against the installation of cast iron pipe less than 6 inches in diameter for service lines has been extended to ductile iron, since it appears that this will not cause any practical problems for the industry and will result in added safety. The possibility of eliminating the use of cast iron in any size for service lines has been suggested, and is currently under consideration. This proposal may be the subject of a future notice of proposed rule making.

Section 192.375. Paragraph (a) of the proposal has been deleted because it is covered in §192.321(c) of Subpart G, General Construction Requirements.

This section also provides that a plastic service line inside a building "must be protected against external damage", in contrast to the former requirement that it "not be exposed".

Section 192.377. Paragraph (a) of the proposal, on the minimum wall thickness for copper pipe used for service lines, has been moved to §192.125 (b) of Subpart C, Pipe Design.

Subpart J – Test Requirements:
Section 192.503. Section 192.503 (b) has been rewritten to make it clear that liquid, air, natural gas, or inert gas may each be used as a test medium, provided that the stated requirements are met.

Section 192.505. The inclusion of the test medium authorizations in §192.503 has made it possible to eliminate the table that was proposed for §192.505(a). The required test pressures in each case may be calculated by applying the factors set forth in §192.619(a) (2) to the desired maximum allowable operating pressure.

Paragraph (c) of §192.505 in the notice proposed to require that field tests be conducted by maintaining the test pressure for at least 24 consecutive hours after the pressure stabilized in all parts of the pipeline facility being tested. Numerous objections were received to the 24-hour requirement. After consultation with the Technical Pipeline Safety Standards Committee, it has been concluded that the evidence available at this time will substantiate a requirement for an 8-hour test, but not for a longer test. The question of test duration will be the subject of further study and, if it is determined that a different test period is warranted, will be covered in a future rule making action.

Section 192.507. The requirements of proposed § § 192.507 and 192.509 have been combined in §192.507. The proposed 4-hour test duration has been reduced to one hour since, as many commenters pointed out, the test requirements of proposed §192.507 are essentially leak test rather than strength test requirements.

Subpart K-Uprating:
Section 192.553. Several commenters objected to the requirements of proposed §192.553(a)(2) that each leak must be repaired before a further pressure increase is made. Section 192.5539(a)(2), as issued, includes an exception for leaks that are determined not to be hazardous, provided they are monitored during the pressure increase and do not become potentially hazardous. This will permit the repair of very minor leaks in the course of routine maintenance.

Section 192.555. The notice proposed that, where a pipeline qualified for an increase in maximum allowable operating pressure, the increase must be made in increments not greater than 25 percent of the total of the proposed increase. Some commenters questioned the need for incremental increases in distribution systems, while others questioned the need for four increments where the total pressure increase was a small percentage of the pressure before the proposed increase. Other commenters questioned the justification for incremental increases where the basis for the proposed uprating was a pressure test.

Section 192.555(e). Requires that, where a pipeline segment qualifies for uprating, the increase in pressure must be made in increments of either--

(1) 10 percent of the pressure before the uprating; or (2) 25 percent of the total pressure increase; whichever requires fewer increments. This will eliminate the need for four incremental increases if the total increase is small as compared to the pressure before uprating. Section 192.557(c) contains a similar provision for pipeline segments that are uprated under that section. Also, §192.555(e) does not require

incremental increases where the basis for the uprating is a new pressure test under paragraph (d)(1) of §192.555.

Section 192.557. Proposed § § 192.557, 192.559, and 192.561 have been combined since the requirements of each proposed section were substantially similar. Several commenters indicated that, while proposed §192.561(b) (4) required the testing of each regulator to determine if it is functioning, it would be impossible to complete such a test without increasing the pressure. Therefore, §192.557(b) (6) has been revised to permit pressure to be increased, as necessary, to test each regulator after a regulator has been installed on each pipeline that is subject to the increased pressure.

Subpart L-Operations:
Section 192.605. In response to comments received, several changes have been made. In paragraph (a), the requirement that the operating and maintenance plan include detailed instructions for employees covering operating and maintenance procedures has been changed by the deletion of the word "detailed."

Paragraph (e), proposed to cover periodic inspection of transmission systems only, has been reworded to also include distribution systems.

Paragraph (f) as proposed in the notice, which required that provisions for a detailed population index survey be included in the operating and maintenance plan, has been deleted, since §192.609 requires that a study must be made whenever an increase in population density indicates a change in class location.

Section 192.607 is a new section on the initial determination or establishment of maximum allowable operating pressure applying to existing pipelines. It has been discussed above.

Section 192.611. In paragraph (c), the word "hydrostatically" has been deleted, since testing must be done in accordance with the applicable requirements of Subpart J and there may be instances where other methods of testing would be permitted under that subpart. Paragraph (e) has been rewritten to provide that the operator shall confirm or revise the maximum allowable operating pressure "within 1 year of the date when a change in class location has occurred", instead of "within 60 days of the date when the operator has notice that a change in class location has occurred", as was proposed in the notice. The reasons for this change are discussed in detail above.

Section 192.613. In response to comments received, paragraph (a) was rewritten by deleting "drop in flow efficiency due to internal corrosion", from the list of conditions to be determined by a continuing surveillance program and by adding "changes in class location" to this list. A drop occurring in flow efficiency cannot necessarily be related to internal corrosion and may be due to other factors.

Section 192.615. Paragraph (d) of this section on emergency plans has been changed by omitting the requirement for an educational program to enable customers and the general public "to know how and when to shut off the supply of gas at the customer's meter in an emergency". Although this requirement was a recommendation of the National Transportation Safety Board, most of the comments indicated that safety would be lessened if inexperienced persons were to close or open the supply of gas. For this reason, the requirement was not included. If further information indicates its desirability, it will be considered for a future notice of proposed rulemaking.

Section 192.617. In accordance with suggestions received in the comments, the selection of samples of a failed facility or equipment for laboratory examination is required only "where appropriate".

Section 192.619. In this section, which establishes the maximum allowable operating pressure for steel or plastic pipelines, new paragraphs (a) (3) and (c) have been added to permit operation at the highest actual operating pressure to which an existing segment of pipeline in satisfactory condition was subjected during the 5 years preceding July 1, 1970. Paragraph (a)(3) also permits operation at a pressure for which a segment of pipeline was qualified by test during that period. This section has been more fully discussed above.

Sections 192.621 and 192.623. In these sections, dealing with maximum allowable operating pressure for high- and low-pressure distribution systems, paragraph (a) (5) of §192.619 and paragraph (a) (2) of §192.621 as proposed in the notice have been deleted, because the definitions of "high-pressure distribution systems" and "low-pressure distribution system" permit the elimination button system" permit the elimination of 2 p.s.i.g. as a dividing line between high and low pressure distribution systems, and have also permitted the use of performance-type language.

Section 192.625. Paragraph (a) of this section limits the applicability of the odorization requirements to mains and service lines. This requirement is discussed above.

Section 192.629. This section on purging of pipelines has been modified to make the procedure for purging air consistent with the procedure for purging gas. Paragraph (c) has been eliminated from this section and moved to §192.751, Subpart M, Maintenance.

Subpart M-Maintenance:
Section 192.701. In accordance with suggestions received in the comments, references to the specific areas of maintenance covered in this subpart have been deleted from this section.

Section 192.703. This is a new section comprised of general provisions. Section 192.703 (a) and (b) was formerly contained in proposed §192.723 (b) (3) and (4).

Sections 192.711 and 192.713. The words "injurious defect, gouge, groove, dent, or leak," have been replaced by "leak, imperfection, or damage that impairs its serviceability," and the definitions contained in the proposal have been eliminated, in order to make this section consistent with Subpart G.

Section 192.715. The words "Each weld found to have an injurious defect" have been eliminated and replaced by "each weld that is unacceptable under §192.241(c)."

Sections 192.713, 192.715, and 192.717. A full encirclement welded split sleeve is required to be "of appropriate design" and the words "greater design strength" have been substituted for the words, "greater wall thickness and grade."

Section 192.725. The provisions concerning service lines "previously abandoned" and service lines temporarily "disconnected" are combined, since in each instance the line must be tested in the same manner as a new service line before being reinstated.

Section 192.727. Sections 192.719 and 192.725 as proposed in the notice have been combined in this section, since the requirements for abandonment of transmission and distribution facilities are substantially the same. Abandoned lines now include lines that are not subject to gas pressure, except when undergoing maintenance. In addition, it is now provided in paragraph (a) that the line need not be purged when the volume of gas is so small that there is no potential hazard. Paragraph (b) requires that, if air is used to purge the line, the operator shall ensure that a combustible mixture is not present after purging.

Section 192.737. Paragraph (b) has been eliminated since the requirements to follow prescribed plans, keep records and promptly correct all unsatisfactory conditions are covered elsewhere.

Section 192.739 and 192.743. Rupture discs are excepted from the periodic testing requirements for pressure relief devices in order to make these sections consistent with §192.731, and because testing of a rupture disc would destroy it and require replacement.

Section 192.751. This section has been modified to require the operator to minimize the danger of accidental ignition of gas in areas where the pressure of gas constitutes a hazard, including the removal of potential sources of ignition when a hazardous amount of gas is being vented into open air, and the prohibition of welding or cutting on pipe containing a combustible mixture of gas and air in the area of work.

Section 192.753. This section requires that all existing cast iron caulked bell and spigot joints, subject to pressure of 25 p.s.i.g. or more must be sealed with mechanical leak clamps. Those subject to pressure of less than 25 p.s.i.g. must be sealed by means other than caulking whenever exposed for any reason. These requirements were transferred to Subpart M from Subpart F (§192.255 as proposed in the notice).

Appendices. The proposed appendices have been relettered so as to appear in the order in which they are referred to in the regulations. This results in proposed Appendixes A and C being exchanged. The materials incorporated by reference have been corrected and the editions listed have been updated to the most recent one. The dates have also been added to the listed specifications in Appendix B, Section I for convenient reference. ASTM specification A 539 has been added to the list in Appendix B.

Report of Technical Pipeline Safety Standards Committee. Section 4(a) of the Natural Gas Pipeline Safety Act required the establishment of a 15-member Technical Pipeline Safety Standards Committee. Section 4(b) of the Act requires that all proposed standards and amendments to such standards be submitted to the Committee and that the committee be afforded a reasonable opportunity to prepare a report on the "technical feasibility, reasonableness, and practicality of each such proposal." Part 192 was submitted to the Technical Committee and that committee has submitted a favorable report. The Committee's report and the minority views of the one Committee member who disagreed with the majority report are set forth below. As indicated in the majority report, several members of the Committee submitted concurring statements recommending further regulatory action in specific areas. These recommendations have been included in the rulemaking docket for Part 192.

SECRETARY OF TRANSPORTATION
400 Sixth Street SW.
Washington, D.C.

Attention: Mr. William C. Jennings, Acting Director
Office of Pipeline Safety

AUGUST 10, 1970.

GENTLEMEN: In accordance with the provisions of Section 4 of the Natural Gas Pipeline Safety Act of 1968, the Technical Pipeline Safety Standards Committee herewith submits its report on the technical feasibility, reasonableness and practicability of the several proposals of the Office of Pipeline Safety which together comprise a "rule establishing comprehensive Federal Pipeline Safety Standards." These minimum Federal safety standards are those which were developed by the Office of Pipeline Safety to comply with the requirements of Section 3(b) of the Act and consist of proposals, and modifications thereto, which were published in the FEDERAL REGISTER as follows:

Notice	Docket	Title	Federal Register publication
60-3	OPS-3	Minimum Federal Safety Standards	34 F.R. 18556
70-1	OPS-3A	Welding and Other Joining of Pipe Components	35 F.R. 1112
70-2	OPS-3B	General Construction Requirements	35 F.R. 3237
70-3	OPS-3C	Customers Meters, Service Regulators and Service Line	35 F.R. 4526
70-4	OPS-3D	Class Location	35 F.R. 5012
70-5	OPS-3E	Operation and Maintenance	35 F.R. 5483
70-6	OPS-3F	Testing and Uprating	35 F.R. 5724
70-7	OPS-3G	Pipe and Component Design	35 F.R. 5713
70-11	OPS-3E	Odorization of Gas-Request for Additional Comment	35 F.R. 9203

The Committee has worked very closely with the Office of Pipeline Safety and has offered technical assistance in a series of meetings in June and July of this year which resulted in material changes in the technical content of the several proposals.

In view of the Committee's close association with the development of the final rule it did not appear appropriate to prepare a separate report on Committee consideration of individual items of the final rule. Therefore, the Committee has, by letter ballot, evaluated the proposed final rule and a majority concurs that the proposed standards accomplished the intent of Congress to establish reasonable minimum standards applicable to the design, installation, inspection testing, construction, extension, operation, replacement, and maintenance of pipeline facilities.

It should be noted from the concurring views, expressed in the attached documents, that a number of the members of the majority are concerned that much work remains to be accomplished in future rulemaking to expand and clarify the rules to further improve the safety of pipeline facilities.

The Committee, in approving the presently proposed final rule, relies on assurances of the Office of Pipeline Safety and the General Counsel of the Department of Transportation that supplemental rulemaking dockets will be instituted to provide opportunity to consider additional items affecting safety of pipeline facilities that were judged to be beyond the scope of Docket OPS-3 and its several subparts. Additionally, the Committee recognizes the necessity for inclusion of "Requirements for Corrosion Control" which is the subject of Notice 70-8, Docket OPS-5 (35 F.R. 7127) and was considered in a public hearing on July 20, 1970, pursuant to Notice 70-12.

The letter ballot canvass of the Committee (copies attached) indicated a vote of 13 approving the majority report and one opposed.

Minority views on specific items (copies attached) were submitted by Committee members Melvin R. Meyerson, A. W. Peabody, Martin T. Bennett, George W. White, Robert I. Snyder, and A. F. Rhodes.

Mr. Lang in voting in opposition to the majority has chosen to refer to the transcripts of the several meetings of the Committee for detail of his proposed alternate to the rule recommended by the majority.

This final Committee action is based on a review of the final rule without benefit of the preamble that will be issued with the rule. Therefore, the Committee has voted on the assumption that the preamble statement will be consistent with the Committee's understanding of the intent of the various requirements as specifically discussed with the Committee at its several meetings with the Office of Pipeline Safety.

LOUIS W. MENDONSA,
Secretary, Technical Pipeline
Safety Standards Committee,

Attachments:
cc: Mr. Sheftel, Bureau of the Budget,
Each committee member.
FREDERIC A. LANG P.E.,
Good Hope Road,
Sandenberg, Pa. 19350.

EXPLANATION OF THE DISAPROVAL BY FREDERIC A. LANG OF THE PROPOSED MAJORITY REPORT ON THE PROPOSED FINAL RULE ESTABLISHING COMPREHENSIVE FEDERAL PIPELINE SAFETY STANDARDS

August 7, 1970
As a member of the Technical Pipeline Safety Standards Committee, I disapprove of the proposed majority report because the proposed Final Rule will establish regulations not measurably more effective than the standards written and suggested by the industry. In fact, the proposed Final Rule is based on the industry standard B 31.8 and has the same deficiencies.

Industry standards do not require more safety than is optimum for profits. The industry standards leave major loopholes available to the pipeline operator in order that the standard or the regulation not result in higher costs which might result from using a safer pipe material or a safer design, construction, or operating practice.

A further weakening of the Final Rule exists because of documents incorporated by reference. The opinion of DOT counsel is that documents incorporated by reference provide the same loopholes (lack of regulation) in this DOT Regulation (Part 192) that exist in the referenced document. Referenced documents were written in most cases by industry groups such as American Petroleum Institute who were not desirous of creating self-imposed regulation and who provided numerous loopholes and options that leave uncontrolled important pipeline safety items.

A suitable alternative Proposed Final Rule was outlined by me and others during the official Committee meeting on the Proposed Final Rule. The transcript of the meetings is available.

FREDERIC A. LANG.

After considering the comments, the recommendations of the Technical Pipeline Safety Standards Committee, and other information discussed above, I have determined that good cause exists for making these regulations effective more than 30 days after issuance.

This amendment is listed under the authority of the Natural Gas Pipeline Safety Act of 1968 (39 U.S.C. §1671 et seq.) , Part 1 of the Regulations of the Office of the Secretary of Transportation (49 CFR Part 1), and the delegation of authority to the Director, Office of Pipeline Safety, dated November 6, 1968 (33 F.R. 16468).

In consideration of the foregoing and for the reasons stated in the series of notices listed above, Title 49 of the Code of Federal Regulations is amended as follows:

Part 190, except for those provisions applicable to design, installation, construction, initial inspection, and initial testing, is revoked effective November 12, 1970.

The provisions of Part 190 applicable to design, installation, construction, initial inspection, and initial testing are revoked effective March 12, 1971.

A new Part 192 is added, effective November 12, 1970, to read as set forth below.

Issued in Washington on August 11, 1970.

NOTE: The reporting and/or recordkeeping requirements contained herein have been approved by the Office of Management and Budget in accordance with the Federal Reports Acts of 1942.

WILLIAM C. JENNINGS,
Acting Director,
Office of Pipeline Safety.

The incorporation by reference provisions in this Part 192 were approved by the Director of the Federal Register on August 18, 1970.

Title 49—Transportation
Chapter 1—Hazardous Materials Regulations Board, Department of Transportation
[Docket No. OPS-5; Amdt. 192-4]
Part 192—Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards

Requirements for Corrosion Control
This amendment establishes a new Subpart I to Part 192 in Title 49, Code of Federal Regulations containing the minimum Federal safety standards for the transportation of gas and for pipeline facilities used in this transportation.

On April 30, 1970, the Department issued a notice of proposed rule making, Notice 70-8, containing requirements for corrosion control (35 F.R. 2127, May 6, 1970). Interested persons were invited to participate in the making of the proposed rules by submitting written comments before June 29, 1970.

On June 6, 1970, an amended notice of proposed rule making was published in the *Federal Register* (Notice 70-10, 35 F.R. 8833) to make certain changes in the proposed rules relating to cast iron and ductile iron pipe. After a request for a public hearing on the requirements of these two notices, a public hearing (see Notice 70-12, 35 F.R. 10596 June 30, 1970) was held on July 20, 1970, and comment was received on the proposed applicability of the requirements to existing pipelines and to cast iron or ductile iron pipe. The information and views presented in the comments and at the hearing have been fully considered, and are reflected in this final rule. Some sections contained in the notice have been consolidated, eliminated, or reorganized and most sections have been renumbered. The derivation table below indicates the corresponding section number in the notice for each section of the final rule

Derivation Table

New Section	**Proposed Section**
192.451	192.451
192.453	192.481(b)
192.455	192.453, 192.455, 192.457
192.457	192.467, 192.469, 192.473
192.459	192.481(a)
192.461	192.455
192.463	192.457
192.465	192.475
192.467	192.463, 192.465, 192.479
192.469	192.459, 192.477
192.471	192.461, 192.477
192.473	192.491
192.475	192.487
192.477	192.487
192.479	192.489
192.481	192.489
192.483	192.481, 192,483, 192.485
192.485	192.483

New Section	**Proposed Section**
192.487	192.485 (a) and (b)
192.489	192.485 (c)
192.491	192.493

Subpart I differs in many respects from the notice upon which it was based. Some changes were made for consistency in terminology and format. Others involve the moving of requirements from one section to another for better organization. Other changes are substantive in nature and are based both on the comments received on the notice and on the recommendations of the Technical Pipeline Safety Standards Committee. Each of these changes is within the general scope of the notice on which it was based

A number of recommendations included in the comments were beyond the scope of the proposed regulations, and could therefore not be included in the final rule. However, these recommendations will be considered for inclusion in future rule-making actions.

Some of the comments were directed to the overall effect of Subpart I, and these general subjects are discussed below. All other significant changes and comments are discussed in a section-by-section analysis.

Effective date. Section 3 (c) of the Natural Gas Pipeline Safety Act requires that standards and amendments thereto prescribed under the Act "shall become effective 30 days after the date of issuance* * *unless the Secretary, for good cause recited, determines an earlier or later effective data is required as a result of the period reasonably necessary for compliance." The notice invited comment on the adequacy of specific proposed effective dates, both as to whether earlier dates would be in the interest of increased safety and whether later dates are indicated by factors of cost of feasibility.

Besides the numerous comments received on proposed effective dates, the question was discussed with the Technical Pipeline Safety Standards Committee. Accordingly, this regulation will become effective 30 days after the date of issue. However, certain specific provisions will not become applicable at once. The primary reason for allowing additional time for these provisions is that the corrosion regulations are new requirements that were not contained in the interim minimum Federal regulations, and it is desirable to allow appropriate leadtime to all affected parties to receive copies of the new regulation and to thoroughly review its requirements and to make the necessary preparations and arrangements for compliance. This additional lead time is contained in provisions relating to cathodic protection of new pipelines [§192.455 (a)(2)]; cathodic protection of existing pipelines [§192.457 (a) and (b)]; interference currents (§192.473); internal corrosion control (§192.475); atmospheric corrosion control of existing aboveground pipelines (§192.479); and corrosion control records (§192.491).

Retroactive effect on existing pipelines. Some comments related to the effect of this regulation on existing pipelines, and suggested the insertion of dates in particular sections to make clear that these sections are not intended to apply to installations, repairs or replacement made before the effective date. [See §192.455 (e) (installation of aluminum); §192.461 (protective coating); §192.467 (electrical isolation); and §192.483 (repaired or replaced pipe).] As stated in the preamble when Part 192 was issued, there is no basis for such concern. The Natural Gas Pipeline Safety Act [Section 3(b)] makes clear that only standards applying to the extension, operation, replacement, or maintenance, and subsequent inspection and subsequent testing are applicable to pipeline facilities in existence on the date the standards are adopted.

However, provisions applicable to existing lines need not be limited to cases in which a facility is hazardous to life or property, as asserted in some comments, but are permissible as part of the regular operation and maintenance requirements for existing lines. The determination of areas of active corrosion on existing pipelines by electrical survey, by study of corrosion and leak history records and by leak detection survey, as well as the application of cathodic protection to such areas, or repaired or replaced areas, and subsequent inspection and testing to determine the adequacy and efficacy of corrosion control, are examples of operation, replacement, maintenance, and subsequent testing and inspection specifically permitted under the Act where a particular section applies only to existing pipelines that is made clear by use of the phrase "pipelines installed before August 1, 1971." [See § § 192.457, 192.479 (b).]

Distinction between high and low stress pipe; distinction between bare and coated pipe. To be consistent with the previously issued subparts of Part 192, the terms "transmission line" and "distribution line" have been substituted for the phrases "pipelines, mains and service lines operating at 20 percent or more of SMYS," and "pipelines, mains, or service lines operating at less than 20 percent of SMYS," which were used in the notice. Some of the comments maintained that the distinction between high- and low-stress pipe, and between bare and coated pipe, was unjustifiable as a basis for differing corrosion control requirements. However, the problems of cathodically protecting existing distribution lines are different from those of existing transmission lines. Special problems make compliance in the case of the distribution lines more difficult, so more time must be allowed for meeting these requirements. In many cases it is more practical to cathodically protect an existing coated transmission line in its entirety than to survey it for "hot spots" and cathodically protect only those areas where active corrosion is found. Consequently, it is required that effectively coated existing transmission lines be cathodically protected within 3 years of the effective date, but 5 years is allowed for existing bare transmission lines, all distribution lines and all station piping.

Distinction based on type of metal. Special provisions deal with specific metals having unique characteristics, such as copper [§192.455 (c)(1)], aluminum [§192.455 (e)], and cast iron and ductile iron (§192.489). However, the phrase "steel or aluminum pipeline," as used in the notice, has been eliminated, since there was no intention to exclude other types of metallic pipe such as wrought iron.
Section 192.451. This section, stating the scope of the subpart, has been rewritten. The word "pipeline" has now been substituted for the words "gas pipeline facilities" and "pipelines, mains, service lines, and related facilities" which were used in proposed §192.451, as well as in many other sections of the notice. As defined in §192.3 "pipeline" means all parts of those physical facilities through which gas moves in transportation, including pipes, valves, and other appurtenances attached to pipe, compressor units, metering stations, regulator stations, delivery stations, holders, and fabricated assemblies. The second sentence of the proposed scope section in the notice was deleted as unnecessary.

Various suggestions were made that the scope section state that these requirements are for the protection of pipelines from "harmful" corrosion, or corrosion "detrimental to safety," or that it states that it prescribes minimum requirements for the protection of pipelines from corrosion, "consistent with public safety," in order to make clear that not every degree or type of existing corrosion imposes an obligation on the operator to take protective steps. These proposals were deemed unnecessary, since their purpose is accomplished by the definition of "active corrosion" in §192.457 (c) as "continuing corrosion which, unless controlled, could result in a condition that is detrimental to public safety." Moreover, under § § 192.485, 192.487, and 192.489, remedial action is required only where corrosion is of the degree or extent described in those sections. In addition, cathodic protection of most existing lines is now required only in "areas in which active corrosion is found" [§ § 192.457 (b) and 192.465 (e)] thus eliminating any implication that an operator must cathodically protect the pipeline in all areas of existing corrosion, even where the operator has not been able to detect it.

Section 192.453. This section, based on proposed §192.481 (b), which applied only to cathodic protection systems, now applies to all procedures to implement the requirements of this subpart, "including those for the design, installation, operation, and maintenance of cathodic protection systems".

Recommendations that some standards be included to assure the competence of the "person qualified by experience and training in pipeline corrosion control methods," or that such a person be qualified under the terms of the accreditation program of the National Association of Corrosion Engineers, were deemed inappropriate at this time. The word "corrosion specialist,' suggested as a substitute for the word "person," was thought to be redundant in view of the additional language, "qualified by experience and training in pipeline corrosion control methods." A person so qualified, but not officially designated as a corrosion specialist, should not be precluded from acting under this section.

Section 192.445. Paragraph (a) of §192.455 requires, with certain exceptions, protection against external corrosion for all newly constructed pipelines, by means of a combination of external protective coating and cathodic protection.

The proposed regulation would have required new buried pipelines to be "cathodically protected not later than 1 year after completion of construction." Since time must be allowed for the environment to reach a stable level due to changes in soil setting and in oxygen and water content of backfill, before final measurements can be taken to determine adequacy of protection, it is now provided that a properly designed cathodic protection system must be "installed and placed in operation within 1 year." An additional year will then be available under §192.465 for any adjustments necessary because of changes in the soil following construction.

No differentiation has been made in §192.455(a) between new transmission and new distribution lines. Except as provided in paragraphs (b) and (c), all new pipelines must be coated and cathodically protected.

New pipe that replaces pipe removed from an existing buried or submerged pipeline because of external corrosion, is covered by §192.483 (a) and (b), but it should be noted that such new replacement pipe also must be coated and cathodically protected.

Paragraph (b) provides an exception to the requirements of paragraph (a). Many comments recommended that an exception to the coating and cathodic protection requirements, similar to that proposed for new copper pipelines (where the operator can demonstrate by test, investigation or experience in the area of application that a corrosive situation does not exist), should be extended to all new pipelines. This has been done in paragraph (b) of §192.455, but with additional safeguards. Certain minimum tests for soil resistivity and corrosion accelerating bacteria will be required. These tests are a prerequisite in every instance of an installation made without complying with the requirements of paragraph (a). In addition, within 6 months after such an installation, the operator must conduct tests, including pipe-to-soil potential measurements and soil resistivity measurements at potential profile peak locations, and the pipeline must be cathodically protected in those areas in which the tests indicate a corrosive condition exists.

Paragraph (c) provides an additional exception to the requirements for coating and cathodic protection, for new temporary pipelines, where the operating period of service is not to exceed 5 years beyond installation.

Paragraph (d) provides that even where protection of a new buried pipeline against external corrosion control is not required under one of these exceptions set out in paragraphs (b) or (c), if the pipeline is coated, it must then also be cathodically protected. This is necessary because first leaks can develop sooner on a coated pipeline than they would on the same line left bare, and second, since harmful discharge of current would be concentrated at the breaks in the coating (holidays).

Paragraph (e) of §192.455 has been modified to incorporate suggested language in regard to installation of aluminum, which is the same as that used in the 1969 edition of NACE Standard RP-01-69. Comments criticized the term "highly alkaline environment" used in the notice as too vague, and suggested that the use of aluminum should be prohibited in "an environment with a natural pH in excess of 8.0," unless tests indicate its suitability in the particular environment involved.

Finally, it should be noted that no exception to the requirements of §192.455 is provided for new cast iron or ductile iron. Because of the unique physical characteristics of its corrosion process (graphitization), and because of the normal allowance of extra wall thickness, it was argued in some of the comments and at the hearing on July 20, 1970, that it should not be required that newly installed cast iron or ductile iron be coated and cathodically protected, but that a loose polyethylene wrap should be considered an appropriate coating adequate for proper corrosion control. But moisture and ground water which can enter the loose polyethylene wrap may form a breeding ground for bacteriological corrosion. Moreover, in the event there is a break in the polyethylene wrap and corrosion started, there is no way to apply cathodic protection to prevent further corrosion. The current would be intercepted by the insulating qualities of the polyethylene sheet, and cathodic protection would only reach the metal under the break. The other areas under the wrap that may be corroding from water and access to oxygen would not be cathodically protected. Therefore, new cast iron and ductile iron have not been treated differently from steel and a coating bonded to the pipe and cathodic protection are required.

Section 192.457. Whereas §192.455, which deals with new pipelines, makes no distinction for corrosion control purposes between new transmission lines and new distribution lines, generally requiring both to be coated and cathodically protected. The entirety of §192.457, which applies to existing pipelines, has different requirements for coating transmission lines than for distribution lines.

Several comments pointed out that coated pipe with deteriorated coating that is no longer effective should be treated as bare pipe for corrosion control purposes. Accordingly, the proposed requirement that coated pipelines operating at 20 percent or more of SMYS must be cathodically protected in the entirety within 3 years, now applies only to existing buried or submerged transmission lines that have an effective external coating (§192.457(a). The effectiveness of the coating is to be established by tests to determine the current requirements of the pipeline for cathodic protection. Coating is deemed ineffective if the cathodic protection current requirements are substantially the same as if the pipeline were bare.

Paragraph (b) of §192.457 provides that except for cast iron or ductile bare transmission lines (including those with ineffective coating), bare or coated station piping, and bare or coated distribution lines, all must be cathodically protected within 5 years in areas in which active corrosion is found. "Active corrosion" is defined in paragraph (c).

The proposed regulation would have required cathodic protection of existing distribution lines and bare transmission lines within 5 years, "in areas in which corrosion exists." The operator was to determine these areas by electrical survey or other means. There appeared to be some concern in the comments that the proposal contained an absolute requirement that every area of existing corrosion be found and protected against within 5 years. This was apparently felt to be impossible for some distribution lines, since determination of areas of corrosion by electrical survey is often impractical in the case of distribution lines (such as those under paved city streets and sidewalks). This has now been changed to require cathodic protection "in areas in which active corrosion is found," and that areas of active corrosion be determined by electrical survey, or "where electrical survey is impractical, by the study of corrosion and leak history records, by leak detection survey, or by other means." This modified language should make clear that the operator is not obligated to take action concerning active corrosion which cannot be found by the required methods. The operator must conduct electrical surveys in areas where they are practical. In other areas, he must make diligent efforts, utilizing leak surveys, all available records such as corrosion and leak history records, or other appropriate methods, to discover active corrosion. Leak surveys could be made by such commonly used means of leak detection as flame ionization, infrared detectors and combustible gas detectors. If these efforts do not indicate the presence of active corrosion, the operator may assume that none exists, until such time as an actual indication of its existence arises. Moreover, it should be noted that an operator may apply for a waiver if it is shown that justification exists for not meeting the 5-year time period in cathodically protecting "hot spots" found by the methods set out in §192.457 (b).

In summary §192.457 now provides that existing, effectively coated transmission lines must be cathodically protected in the entirety within 3 years, while all other existing lines (including bare transmission lines, bare or coated buried station piping operating at above or below 20 percent of SMYS, and bare or coated distribution lines) must be cathodically protected within 5 years in areas in which active corrosion is found. On new construction §197.455 provides that all new pipe (both transmission and distribution) must be coated and cathodically protected within 1 year of installation unless the operator can demonstrate that a corrosive environment does not exist.

Section 192.459. The requirement that whenever any buried piping is exposed for any reason it must be examined for evidence of external corrosion has been modified. Comments suggested that it be made clear that this requirement would not necessitate tearing off good coating to examine the pipe. As the section is rewritten, it requires only that "Whenever an operator has knowledge" that any portion of buried pipeline is exposed, the pipe must be examined for evidence of external corrosion "if the pipe is bare or if the coating is deteriorated."

Section 192.461. This section, dealing with protective coating, has been slightly reworded.

Subparagraph (1)(2) requires a protective external coating to have sufficient adhesion to the metal surface to "effectively resist" (rather than "prevent") underfilm migration of moisture, in response to comments asserting that the coating could not absolutely prevent underfilm migration of water.

Paragraph (c) relating to inspection of coating prior to lowering the pipe and backfilling, now requires repair only of "any damage detrimental to effective corrosion control," since the comments indicated that minor damage often does not require repair.

Paragraph (e) is a new paragraph requiring that precautions be taken to minimize damage to coating during installation by boring or driving. This paragraph, although proposed in Notice 70-3, Subpart H (Customer's Meters, Service Regulators, and Service Lines) as proposed §192.429 (b), was omitted in the final rule for that subpart, since it was considered to be more properly a part of the corrosion subpart.

Section 192.463. Paragraph (a) of this section refers to the criteria for cathodic protection contained in a new Appendix D, rather than to paragraph 6.3 of the 1969 edition of NACE Standard RP-01-69. However, it should be noted that the criteria in the appendix are substantially the same as those in the NACE Standard RP-01-69. In addition, it is now provided that "If none of these criteria is applicable, the cathodic protection system must provide a level of cathodic protection at least equal to that provided by compliance with one or more of these criteria." It was felt that the possibility of an exception should be provided, but that where the criteria are applicable, they should be followed.

In accordance with several suggested comments, paragraph (d) of proposed section 192.457 was deleted as unnecessary, and paragraph (f) of that proposed section has been reworded to eliminate the requirement that the cathodic protection "assure proper performance of the protective coating system," and instead now requires that the amount of cathodic protection must be controlled "so as not to damage the protective coating or the pipe."

Section 192.465. The section on monitoring differs from the proposal in several ways. It applies to monitoring of both new and existing lines. In paragraph (a), offshore pipelines, where monitoring is impractical, have been excepted. The phrase "at intervals not exceeding 12 months" has been changed to "at least once each calendar year, with intervals not exceeding 15 months." The purpose of the change was to allow seasonal consideration in scheduling annual inspections, and it was felt that 3 months leeway would provide sufficient flexibility for this purpose.

Instead of requiring that each interference bond be electrically checked for proper performance at intervals not exceeding 2 months, it is now provided in §192.465 (c) that each interference bond "whose failure would jeopardize structure protection," must be electrically checked for proper performance at intervals not exceeding 2 months. Each other interference bond must be checked at least annually, but with intervals not exceeding 15 months.

Section 192.467. This section, entitled "External corrosion control: Electrical isolation," is based on the proposed sections which dealt with electrical insulation on new construction and existing pipelines, and with clearance between pipe and underground structures on new construction.

Paragraph (a) still requires that each buried pipeline must be electrically isolated from other underground metallic structures, but in accordance with suggestions received, it permits an exception if the pipeline and the other structures are electrically interconnected and cathodically protected as a single unit.

Paragraph (b) of §192.467, requires that an insulating device be installed where electrical isolation of a portion of a pipeline is necessary to facilitate corrosion control. It was felt that this performance-type language is sufficient to cover such specific situations as the necessary insulation of ferrous valves and fittings installed in underground copper service lines.

Paragraph (c) of §192.467, providing for electrical isolation of the pipeline from metallic casings that are a part of the underground system, now permits other measures to minimize corrosion of the pipeline inside the casing, where isolation is impractical. The additional language was added in response to comments suggesting that this requirement should not apply to a service going through a casing in a cement or masonry wall, where the casing is above ground. Other measures that may be taken include placing a noncorrosive casing filler made of high dielectric material in the annual space between the pipe and casing.

Paragraph (f) concerning protection against damage due to fault currents and lightning now refers to "areas where fault currents or unusual risk of lightning may be anticipated."

Proposed §192.463 (e) has been eliminated as unnecessary, since the specific situations described in that paragraph are covered by the more performance-oriented type of language of §192.467 (a) and (b).

Section 192.473. This section now requires that after July 31, 1973, each operator whose pipeline system is subjected to stray currents must have a continuing program to minimize the detrimental effects of such currents. Comments indicated that the 12-month leadtime originally proposed was insufficient for the acquisition of manpower and equipment for such a program.

Sections 192.475 and 192.477. These sections are essentially the same as proposed. However, paragraph (c) of §192.475, providing that gas containing more than 0.1 grain of hydrogen sulfide per 100 standard cubic feet may not be stored in pipe-type or bottle-type holders, is newly added. It was originally proposed as part of Notice 70-7, Subpart D (Design of Piping System Components and Facilities), as proposed §192.168 (b), but was not included in Subpart D, since it was considered to be more appropriately within the corrosion subpart.

In response to comments, §192.477 makes clear that coupons are required only "if corrosive gas is being transported." However, it should be noted that §192.475 (b) applies also in cases where corrosive gas is not being transported, but internal corrosion is caused by other factors.

Sections 192.479 and 192.481. The sections on atmospheric corrosion control have been completely rewritten. The proposal would have required all new and existing steel, cast iron and ductile iron aboveground pipelines to be coated or jacketed within 1 year for the prevention of atmospheric corrosion. This requirement would have applied to aluminum and copper pipe only when exposed to an atmospheric environment corrosive to those metals.

The comments objected to the 1 year time limitation as insufficient, and also suggested that coating only be required where atmospheric corrosion was actually taking place. While §192.479 (a), applying to newly installed aboveground investigation or experience in the area of application that a corrosive atmosphere does not exist.

Paragraph (b), applying to existing aboveground pipelines, now requires that they be cleaned and coated within 3 years, but only in areas where atmospheric corrosion has taken place on the pipeline.

Section 192.481 requires that at intervals not exceeding 3 years, aboveground pipelines must be reevaluated and necessary action taken to maintain protection against atmospheric corrosion.

Section *192.483.* This section on general remedial measures requires that all new replacement pipe installed because of external corrosion (including cast iron or ductile iron) must be coated and cathodically protected, as is required for new pipelines in §192.455 (a). The exception to these requirements allowed for new pipelines in §192.455 (b) (where the operator can demonstrate that a corrosive environment does not exist), would not apply to replacement pipe, where replacement is necessitated by external corrosion, since it would normally be impossible to make such a demonstration. However, it should be noted that if copper pipe is used to replace corroded steel, cast iron or ductile iron, the provisions of §192.455 (c) (2) might permit the use of uncoated copper replacement without cathodic protection, in the highly unlikely event that the operator could demonstrate by test that the environment (which had been corrosive to the other metals) was not corrosive to copper.

Except for repaired cast iron or ductile iron, a segment of buried pipe that is repaired because of external corrosion must be cathodically protected. Repaired cast iron and ductile iron are excepted from the cathodic protection requirement because the density of cathodic protection current, as normally provided by galvanic anodes, is not sufficient to reach the cast iron beneath the graphitized surface so as to prevent further graphitization. Current of such low density from such low electromotive force collects on the graphitized area and continues through adjacent cast iron and back to the galvanic anode source without providing protection.

It should be noted that at this time, the regulations are not requiring that repaired pipe be coated in every case, since it is not always practical to do so, especially where the repair is in a very small area, or on a bare pipeline. However, where the repaired segment is part of an effectively coated pipeline, the repaired area would also have to be coated.

The proposed regulation provided that generally corroded pipe would not need to be replaced or repaired if the operating pressure were reduced so as to be commensurate with the specified limits on operating pressure based on the actual remaining wall thickness. That option is retained in §192.485(a) covering general corrosion on transmission lines. However, §192.487(a) dealing with general corrosion on distribution lines does not provide the option of reducing operating pressure instead of replacing the pipe. Since such lines are already operating at low pressure, the reduction of pressure would be meaningless.

In this connection, it should be noted that the minimum percentage of remaining wall thickness required in such cases is not contingent on internal pressure (hoop stress) but on external loads.

Sections 192.485 and 192.487. The proposed regulations dealing with remedial measures for isolated corrosion pitting were the subject of considerable comment. Based on the information available at this time, the Department has developed the following regulations which are considered adequate to protect the public:

§192.485 Remedial measures: transmission lines.
(b) *Localized corrosion pitting.* Each segment of transmission line pipe with localized corrosion pitting must be replaced or repaired, or the operating pressure must be reduced based on the actual remaining wall thickness in the pits, if either of the following exists:

1. The diameter of the pits as measured at the surface of the pipe is greater than three times the nominal wall thickness of the pipe.

2. The remaining wall thickness at the bottom of the pits is less than 20 percent of the nominal wall thickness.

However, we are aware that the completion of research now going on is anticipated in the near future, on the subject of the effect of pitting on the integrity of pipe, requiring repair or replacement for the protection of the public. Accordingly, the Department intends to delay the issuance of these regulations on localized corrosion pitting, in order to hold a public hearing on July 20, 1971, to explore the problem further. (See p. 12309 of this issue.) This will give interested persons an opportunity to present new material or to demonstrate that the criteria set out above are inappropriate.

In issuing this rule, the Department has included general criteria on corrosion pitting in § § 192.485 (b) and 192.487 (b) as interim regulations. These interim regulations give the operator discretion to determine the severity of pitting that requires remedial action

Unless the hearing discloses information indicating other criteria are more appropriate, the regulations set forth above in this preamble will be substituted for the interim provisions within 60 to 90 days from the effective date of this regulation.

Section 192.491. The comments on this provision urged that construction drawings and records should not both be required, and that records or drawings should not be required as to all neighboring structures. In response to these comments, §192.491 (a) now requires that "records or maps" be maintained to show the location of cathodically protected piping, cathodic protection facilities "other than unrecorded galvanic anodes installed prior to August 1, 1971," and neighboring structures that are "bonded to" the cathodic protection system.

In response to other comments urging that the retention of all records of tests, surveys, and inspections is unnecessary and unduly burdensome, paragraph (b) now provides for retention only of records, tests, and inspections in sufficient detail to demonstrate the adequacy of corrosion control measures, or, in the case of unprotected pipelines, that a corrosive condition does not exist.

Appendix D. An appendix has been added, setting out criteria for cathodic protection required by §192.463 (a), and methods of determining such measurements as voltage, voltage shifts, and polarization voltage shifts. These criteria and methods of measurement are based on the 1969 issue of the National Association of Corrosion Engineers' Standard RP-01-69, Recommended Practice—Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

Report of Technical Pipeline Safety Standards Committee. Section 4 of the Natural Gas Pipeline Safety Act requires that all proposed standards and amendments to such standards be submitted to the Committee and that the Committee be afforded a reasonable opportunity to prepare a report on the "technical feasibility, reasonableness, and practicality of each such proposal." This amendment to Part 192 has been submitted to the Technical Committee and that Committee has submitted a favorable report. The Committee's report and the minority views of the Committee member who disagreed with the majority report are set forth below.

June 21, 1971.

Memorandum to: The Secretary of Transportation, Attention: Joseph C. Caldwell, Acting Director Office of Pipeline Safety.

From: Secretary, Technical Pipeline Safety Standards Committee.
Subject: Office of Pipeline Safety Proposed Requirements for Corrosion Control (Part 192, Subpart I).

The following letter and attachments represent an official report by the Technical Pipeline Safety Standards Committee concerning the Committee action related to "Requirements for Corrosion Control (Part 192, Subpart I)" which the Office of Pipeline Safety proposes to adopt as a part of Minimum Federal Safety Standards: Transportation of Natural and Other Gas by Pipeline.

The Committee reviewed proposals of the Office of Pipeline Safety at a meeting held on April 13-14, 1971, and through an informal ballot procedure recommended modification to the OPS proposed regulations. The Office of Pipeline Safety considered the recommendations of the Technical Committee and prepared a revised draft regulation which reflected recommendations of the Committee. The revised draft regulation accompanied by a "Discussion of Technical Committee Recommendations" prepared by OPS was distributed to the membership of the Committee on May 4, 1971, by the undersigned together with a formal letter-ballot.

The results of the letter-ballot as finally tabulated reveal that 13 members of the committee approved the proposed regulation as being technically feasible, reasonable and practicable. One member disapproved the proposed regulation.

Attached, as Item A, are the minority views expressed by the dissenting Committee member.

Also attached, as Item B, is a summary of views expressed by Committee members who voted in favor of the proposed regulation but disagreed with minor specifics.

Louis M. Mendonsa.

EXPLAINATION OF THE DISAPPROVAL BY FREDERIC A. LANG OF THE PROPOSED MAJORITY REPORT ON THE PROPOSED PART 192 SUBPART 1 "REQUIREMENTS FOR CORROSION CONTROL."

As a member of the Technical Pipeline Safety Standards Committee, I disapprove of the proposed majority report because it is less than adequate for providing safety to the public living beside gas pipelines, distribution lines, and mains.

Design and operation of pipelines as regulated by Federal Pipeline Safety Standards Part 192 already issued except for this Subpart I, does not contemplate any weakening of the pipe wall by corrosion, therefore, the "Requirements of Corrosion Control" as proposed, should guarantee, within practical limits, that corrosion does not occur. Unfortunately, the regulations as drafted are less than adequate to prevent a dangerous degree of corrosion.

My comments on the need for better corrosion control appear in the transcript of the Committee meetings held April 13 and 14, 1971, to discuss the proposed regulation. In summary, my recommendations are that cathodic protection be used on all piping at all times to prevent corrosion and that scientifically designed sampling be used to determine whether corrosion has occurred. When corrosion has occurred the piping should be replaced or downrated in accordance with the remaining wall thickness available to contain the pressurized gas.

Frederic A. Lang.
This regulation is issued under the authority of the Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. §1671 et. seq.), Part 1 of the Regulations of the Office of the Secretary of Transportation (49 CFR Part 1), and the delegation of authority to the director, Office of Pipeline Safety, dated November 6, 1968 (33 F.R. 16468).

In consideration of the foregoing, a new Subpart I is added to Part 192 of Title 49 of the Code of Federal Regulations, effective August 1, 1971, to read as set forth below.

Issued in Washington, D.C., on June 25, 1971.
Joseph C. Caldwell,
Acting Director,
Office of Pipeline Safety.

Title 49—Transportation

Chapter 1—Hazardous Materials Regulations Board, Department of Transportation

[Amdt. 192-5; Docket No. OPS-11]

Part 192-Transportation Of Natural And Other Gas By Pipeline: Minimum Federal Safety Standards

Extension of Time for Confirmation or Revision of Maximum Allowable Operating Pressure

The purpose of this amendment is to extend the time under §192.607(b) for completing confirmation or revision of the maximum allowable operating pressure (MAOP) of pipelines operating at more than 40 percent of specified minimum yield strength (SMYS). The amendment also provides for the preparation of comprehensive plans for the completion of this work.

On August 11, 1970, the Department issued Federal safety standards for the transportation of gas and pipeline facilities (35 F.R. 13247, August 19, 1970) replacing the interim standards which had been in effect since 1968. These standards established new definitions for class locations which, among other things, are utilized in the establishment of MAOP for pipelines operating at more than 40 percent of SMYS. Concomitantly, a requirement was included that a study be conducted of all pipelines operating at more than 40 percent of SMYS to ascertain their class location, and that the MAOP of these pipelines be confirmed or revised in two steps, by January 1, 1972 and January 1, 1973.

However, the Department recognized that considerable diversity of opinion existed as to the time required to complete confirmation or revision of the MAOP of these pipelines and that information on the number of class location changes was incomplete. It was therefore indicated that a public hearing would be held subsequent to the study to give all interested parties an opportunity to recommend adjustments to the schedule set forth in §192.607(b). That hearing was held on May 12, 1971, and information and recommendations were presented by a number of operators. The transcript of the hearing and copies of written submissions are included in the public docket on this amendment.

Based on the information presented, the Department believes that an extension of the time for confirmation or revision of MAOP is warranted. This extension will permit more effective use of exchange agreements to avoid disruption of gas supplies. In order to meet the 1972 and 1973 deadlines, the operators would have to complete confirmation or revision of operating pressures before completion of the construction or uprating necessary to maintain established throughput. In many cases, this would result in reduction of operating pressures, causing a substantial curtailment of already short gas supplies. In view of the continuing shortage of energy in some areas of the country, it would not be desirable to require pressure reductions that could disrupt service or cause reduction of storage volumes. In addition, the extension of time permits more efficient utilization of the manpower and equipment available for construction and uprating of pipelines.

Therefore, the time for completing a confirmation or revision determined to be necessary by the study is extended for 2 years, through the end of 1974, with a single completion date for all pipelines rather than a two-step deadline as is now provided. To assure completion within that time, each operator must prepare a comprehensive plan, including a schedule, for carrying out these confirmations or revisions. This plan must be modified periodically in accordance with §192.139c) so as to reflect changing conditions and to assure completion within the required time.

A related change has also been made to §192.611(e) which established the minimum time for confirming or revising the MAOP due to a class location change occurring subsequent to the April 15 study. Since pipeline construction and testing cannot be conducted in many areas of the country during the winter months and since several months lead time is usually required to plan for continuity of service, to order materials, and to design the facilities, one year generally is not adequate for this purpose. Therefore, the time period has been extended to 18 months. This assures the operator of adequate planning time in advance of a construction season before he begins the work and testing associated with confirmation or revision.

The change to §192.611(e) is made so as to provide for integrating future confirmations or revisions with the overall comprehensive plan. Existing confirmation or revision projects and those which are required by class location changes occurring before July 1, 1973, must be included in the initial comprehensive plan or integrated into it as they become necessary. These confirmations or revisions must be completed no later than the time for completion of the overall plan, i.e., by December 31, 1974. Confirmation or revision required by a change in class location occurring on or after July 1, 1973, must be completed within 18 months of the change in class location. These requirements are also reflected in the second sentence of §192.607(c).

Since the operators are making a concerted effort during the present construction season to meet the earlier deadlines, and since this is a substantive change that relieves a restriction, I find that notice and public procedure thereon are impracticable and that good cause exists for making this amendment effective on less than 30 days notice.

In consideration of the foregoing, Part 192 of Title 49 of the Code of Federal Regulations is amended as follows, effective immediately.

1. Section 192.607 is amended by revising the section heading and paragraph (b), and by adding a new paragraph (c) at the end thereof, to read as follows:

§192.607 Plan for confirmation or revision of maximum allowable operating pressure.

(b) Each segment of the pipeline that has been determined under paragraph (a) of this section to have an established maximum allowable operating pressure producing a hoop stress that is not commensurate with the class location of the segment of pipeline and that is found to be in satisfactory condition, must have the maximum allowable pressure confirmed or revised in accordance with §192.611. The confirmation or revision must be completed not later than December 31, 1974.

(c) Each operator required to confirm or revise an established maximum allowable operating pressure under paragraph (b) of this section shall, not later than December 31, 1971, prepare a comprehensive plan, including a schedule for carrying out the confirmations or revisions. The comprehensive plan must also provide for confirmations or revisions determined to be necessary under §192.609, to the extent that they are caused by changes in class locations taking place before July 1, 1973.

2. Section 192.611(e) is revised to read as follows:

§192.611 Change in class location: Confirmation or revision of maximum allowable operating pressure.

(e) Confirmation or revision of the maximum allowable operating pressure that is required as a result of a study under §192.609 must be completed as follows:

1. Confirmation or revision due to changes in class location that occur before July 1, 1973, must be completed not later than December 31, 1974.

2. Confirmation or revision due to changes in class location that occur on or after July 1, 1973, must be completed within 18 months of the change in class location.

[Natural Gas Pipeline Safety Act of 1968, 49 U.S.C. Sec. 1671 et seq: Part 1. Regulations of the Office of the Secretary of Transportation, 49 CFR Part 1, delegation of authority to the Director, Office of Pipeline Safety, November 6, 1968 (33 F.R. 16468).]

Issued in Washington, D.C., on September 7, 1971.

JOSEPH C. CALDWELL
Acting Director
Office of pipeline Safety.

[FR DOC. 71-13296 Filed 9-9-71; 8:48am]

APPENDIX E

MAOP BACKGROUND AND HISTORY

DRAFT

Report

on

MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) BACKGROUND & HISTORY

March 5, 1998
(revised June/98 KGL)

For the

GAS RESEARCH INSTITUTE

By

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MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) BACKGROUND & HISTORY

INTRODUCTION

This report presents information on the background and history of MAOP extending back to the early American Standards Association for pressure piping (ASA B31.1) issued in the 1930's, and following the evolution of MAOP's in the piping codes on up to the present time. This will be done to the extent that information is available.

OBJECTIVE

The objective of this study was to present information in a manner that can be a basis for future developments in the formulation of other factors and criteria in setting MAOP's. Some background is presented to show how the ASME B31.8 Committee developed and adopted the 80 percent stress level within the Code.

APPROACH

In order to develop the background and history of the MAOP's presently in the ASME B31.8 Code for Gas Transmission and Distribution Piping Systems, I made an in- depth search of my own files, applicable literature, previous research, and my own experience within the ASME B31.8 Committee. The focus of this study was the origin of the 72 percent SMYS, class location safety factors, and the 80 percent SMYS.

BACKGROUND

The code for natural gas pipelines began in the U.S. as a part of the American Standards Association Code for Pressure Piping, ASA B31.1. This code was originally published in 1935 as an American Tentative Standard Code for Pressure Piping covering Power, Gas, Air, Oil and District Heating. Following the incorporation of Refrigeration to the scope, ASA B31.1 was published as the American Standard Code for Pressure Piping in 1942.

After this time there were additions and/or supplements published in 1944, 1947, and 1951. In all these publications the gas code was characterized under Section 2, Gas and Air Piping Systems. In 1952, the code was subdivided and the gas code became the Gas Transmission and Distribution Piping Systems Code, issued as ASA B31.1.8. This document incorporated material from Sections 2, 6 and 7 of the 1951 Edition of the Pressure Piping Code, making it a stand alone code.

In 1952 a new committee was organized to write code material for the new Section 8. This committee was chaired by Fred A. Hough (Ref. 1). The committee was charged to develop code material to reflect new materials and methods of construction and operations. This group made many changes including design philosophy for the class location concept. This material was incorporated and published in ASA B31.1.8 in 1955. In 1958 further revisions were published in ASA B31.8. Since that time the Section 8 Code Committee has published revisions in 1963, 1966, 1967, 1968, 1975, 1982, 1986, 1989, 1992, and 1995.

This report will show the concepts used to develop the Maximum Allowable Operating Pressures (MAOP's) for the various Editions of the Code.

HISTORY

Origin of 72 Percent of the SMYS

The appropriate MAOP for pipelines was one of the fundamental matters that had to be resolved. The committee needed to find some basis for establishing the MAOP for pipelines. Many operators felt that the MAOP should be based on a test pressure. The problem was that pipeline operators were utilizing a wide variety of field pressure tests. Some operators were testing pipelines to 5 or 10 psig over operating pressure. One reason for these relatively low test pressures was that testing was done with gas. In order to establish a consistent basis for MAOP, the committee agreed that the mill test pressure would be used and the rule would apply to all pipe. Customarily the mill test was 90 percent SMYS. The committee agreed that to be consistent, the MAOP for cross country pipelines should be 80 percent of the 90 percent SMYS mill test, which would be 72 percent of the SMYS. The 72 percent SMYS first appeared in 1935 in the American Standards Association Code for Pressure Piping, ASA B31.1.

The 1951 Edition of the B31.1 Code (ASA B31.1.8), for cross country pipelines, included the 72 percent SMYS (80% of 90% mill test) and provided an equation to define wall thickness based on this maximum pressure and nominal wall thickness. This code further identified a lower stress for pipe in compressor stations, which was limited to a percentage of the 80 percent of mill test as a function of diameter of the pipe diameter which was: 22% for 0.405 inch OD (OD = outside diameter and smaller pipe, 49% for 3.5 inch OD pipe, 72% for 8.625 inch OD pipe, and 90% for 24 inch OD and larger pipe. Therefore, for large diameter pipe in compressor stations, percent of SMYS allowed would have been 90% × 80% × 90% hence 65% of SMYS. The only other indication of limit on MAOP was 50 percent SMYS inside the boundaries of cities and villages.

As mentioned previously, the gas code was first issued as a stand alone code in 1952 in ASA B31.1.8 Gas Transmission and Distribution Piping Systems under a new committee chaired by Fred A. Hough (Ref. 2). This committee was charged with the responsibility of maintaining and updating the code. Over a two and one half year period, this Committee developed the ASA B31.1.8 - 1955 Gas Transmission and Distribution Piping Systems Code. During this time the MAOP was one of the items that was considered. Prior to this time the gas transmission code limited the MAOP to 72 percent SMYS in all locations except "inside incorporated limits of towns and cities" and certain limits in compressor stations. The MAOP in these areas were limited as indicated above.

Some in this committee felt that MAOP should be based on the field test. Hydrostatic test, with a water medium, was done by some operators to much higher pressures than had been done in the past. However, other operators continued to conduct field testing to the lower pressures. For this reason, basing the MAOP on field test pressure was unacceptable to these operators. The acceptable solution was finally found in adopting the long established practice of using 80 percent of 90 percent mill test pressure for MAOP in cross country pipelines.

There was a realization by this Committee that there was a need to consider intermediate levels of pipeline stress levels based on population density and other special conditions.

Establishing Stress Levels For Class Locations

In 1955, the second edition of the American Standard Code for Pressure Piping, Section 8. ASA B31.1.8 - 1955 Gas Transmission and Distribution Piping Systems was published. This document was the first to designate four types of construction to be used based on population density. Prior to 1955, code editions permitted a maximum operating hoop stress of 72 percent SMYS in all locations except those inside the incorporated limits of cities and towns. In these areas a maximum hoop stress of 50 percent SMYS was specified. Between 1952 and 1955 the Section 8 Subcommittee realized that there was a need to delimit areas of population density and establish hoop stress limits below 72 percent SMYS that would be appropriate in each area to protect public safety. Many operators were reducing the stress levels below 72 percent SMYS in certain areas although there were no code criteria to indicate which intermediate stress levels should be used for the various degrees of population density. These operators had adopted various lower stress levels for population density areas, as well as road and railroad crossings, but the criteria were not uniform among operators.

In order to study and evaluate how population densities could be classified and appropriate hoop stress levels could be established, the Section 8 Committee formed a subgroup to address this problem. The subgroup elected to use a ½ mile corridor with the pipeline as the centerline and to establish areas of population density within the corridor in running miles along the pipeline. An aerial survey of many miles of existing major pipelines was conducted to see what percentage of these pipelines would be impacted by areas of population density where lower stress levels should be applied to enhance public safety. A consulting engineering firm was engaged to evaluate the results. Reportedly, at the time of this study, it was found that about 5 percent of the total pipelines surveyed would be impacted by population density requiring stress levels below 72 percent SMYS. The subgroup determined that the population density in the ½ mile corridor traversed by the pipeline should be evaluated according to a building count along both 1 mile and 10 mile sections to establish a population index to define hoop stress levels to identify type of construction in each area. From this study, it was determined that class locations based on a population density index was needed as follows:

Class 1, (72% SMYS) Sparsely Populated Areas
Class 2, (60% SMYS) Moderately Developed Areas
Class 3, (50% SMYS) Developed Residential and Commercial
Class 4, (40% SMYS) Heavy Traffic and Multistory Buildings

In addition, types of construction were established as follows:

Type A (72% SMYS)
Type B (60% SMYS)
Type C (50% SMYS)
Type D (40% SMYS)

The type construction identified the hoop stress allowed in certain locations. For example uncased highways and railroad crossing in a Class 1 (72% SMYS) location would require a Type B (60% SMYS) construction in the crossing.

It is important to note that the ½ mile corridor width selected to establish the population index was not selected as one that would be a hazardous zone in the event of pipeline failure. The ½ mile corridor was one of convenience because the width of typical aerial photographs at that time were conducive for the purpose and could be used to evaluate nearby activities that may impact the pipeline safety in the future.

The reason population density is of concern near the pipeline is that the greater concentration of the public results in greater activity which may cause damage to the pipeline. Some of these activities are trenching for water and sewer lines, terracing, cutting for streets and other digging in the proximity of the pipeline. The lower stress levels are used so that in the event of limited outside damage to the pipeline from these activities, the pipeline may not fail causing a hazard to the public.

This defined ½ mile corridor width remained in the Code until the 1982 Edition of ASME B31.8, at which time the corridor was reduced ¼ mile because experience had shown that activity from population density over 1/8 mile from the pipeline would not cause damage to the pipeline. Also when pipeline failures occurred, impact on people or property was minimal beyond the 1/8 mile half corridor width.

The Federal Regulations (49 CFR 192) were issued in 1970 as a result of the Pipeline Safety Act of 1968, by the Office of Pipeline Safety (OPS). Although OPS adopted much of the 1968 Edition of ASME B31.8, they reduced the corridor width from ½ mile to ¼ mile. This was done in a Notice of Proposed Rule Making (NPRM) in which the following was stated (Ref. 3):

> "A recent study that included hundreds of miles of pipeline right-of-way areas indicated that a zone of this width is not necessary to reflect the environment of the pipeline. A ¼ mile wide zone extending one-eighth of a mile on either side of the pipeline appears to be equally appropriate for this purpose. It would be an unusual instance in which a population change more than one-eighth of a mile away would have an impact on the pipeline. Conversely, an accident on the pipeline would rarely have an effect on people or buildings that were more than an eighth of a mile away. For these reasons, it appears that the density zone can be reduced from one-half to one-quarter of a mile without any adverse effect on safety."

Development of 80% SMYS MAOP

In the early 1950's testing equipment, procedures and technology were developed to test pipelines with water, and some operators began hydrostatic testing. These operators were safely testing to higher pressures with water in contrast to earlier more risky testing with gas. Some operators readily recognized the value of hydrostatic testing as a new tool to prove the integrity of the pipeline. Some operators were hydrostatically testing to 100 percent of the actual minimum yield strength as determined by steel mill metallurgical test.

One operator determined the actual minimum yield strength by hydrostatic test from the pressure versus volume plot. The pressure-volume plot was made by starting the plot below the mill test pressure to establish a straight line (below initial deviation). The actual minimum yield strength was determined when the slope of the line became one-half of the slope of the straight line portion of the plot. By using actual minimum yield strength, MAOP's much greater than 72 percent SMYS were established. This allowed a means to establish a known safety factor between MAOP and test pressure allowing pipelines to be operated at 80 percent SMYS or greater. In addition, essentially all defects present during the test that may fail at MAOP were removed by testing to actual minimum yield.

After approximately 16 years of research, study and testing to prove the value of testing to actual minimum yield, the technology was documented and published in the AGA REPORT L 30050, 1968 (Ref. 4). Many in the pipeline industry realized the merits of hydrostatic testing to actual minimum yield to:

1. Increase the known safety margin between MAOP and test pressure;
2. Prove the feasibility of operating safely above 72 percent SMYS with a greater known safety factor;
3. Remove defects that might fail in service; and
4. Improve the integrity of the pipe.

Based on this experience, a proposal was made to ASME B31.8 to allow operation of pipelines above 72 percent SMYS around 1966 - 1967. Unfortunately the proposal to allow the operation of pipelines at 80% SMYS received some unresolved negative votes which precluded inclusion in the 1968 Edition of ASME B31.8 and before the B31.8 committee could resolve the issue and amend the code the Pipeline Safety Act of 1968 was enacted.

In 1968, the Office of Pipeline Safety (OPS) adopted the 1968 Edition of ASME B31.8 as an interim safety standard until 1970 at which time OPS issued the final rules as Title 49 Code of Federal Regulations Part 192 (49 CFR 192). When issued, Title 49 CFR 192 was almost verbatim from the 1968 Edition of ASME B31.8, hence, the MAOP in Class 1 locations for pipelines installed after November 11, 1970 became 72 percent SMYS. Those pipelines built before November 11, 1970 operating above 72 percent SMYS could continue operating at those pressures if they qualified under the "grandfather clause" in the Federal Regulations. The "grandfather clause" essentially said that not withstanding all other requirements for establishing MAOP for new pipeline that:

> "... an operator may operate a segment of pipeline found to be in satisfactory condition, considering its operating and maintenance history, at the highest actual operating pressure to which the segment was subjected during the 5 years preceding July 1, 1970, or in the case of offshore gathering lines, July 1, 1976 ..." (Ref. 5)

This is subject to the requirements of change in class location.

The "Grandfather Clause" is for pipelines built before the Federal Regulations were issued. When a class location change occurs, that portion of the pipeline class location unit must meet the requirements of a new pipeline, i.e., pipelines under the "grandfather clause" which operate above 72 percent of SMYS would no longer be able to do so and no new pipelines constructed after the Federal Regulations were issued could be qualified above 72 percent SMYS.

After the Federal Regulations became effective, many operators failed to see a role for the ASME B31.8 in the regulatory environment. At this time the B31.8 committee essentially disbanded, however, in 1974 operators realized that unless code activities were resumed, pipeline technology would not advance beyond the 1968 Edition of ASME B31.8. It became apparent that unless the B31.8 code was maintained ASME would withdraw support and American manufacturers would be required to use foreign standards and specifications which might handicap them in the international arena. The B31,8 code is used in the Middle East, South America and many other international regions. In addition, American valve manufacturers and fabricators would be forced to build to foreign specifications in the absence of the ASME B31.8 Code which references U.S. specifications and standards. Consequently, the Code Committee met in 1974 and published the 1975 Edition to preserve the Code.

In the latter part of the 1970's, the proposal to allow pipelines to operate up to 80 percent SMYS was again submitted to the ASME B31.8 Code Committee. The Committee worked several years to develop criteria and requirements for the design, hydrostatic testing and ductile fracture control for pipelines to be operated up to 80 percent SMYS. The greatest opposition came from pipe manufacturing members of the Committee. The pipeline operator Committee members realized that transporting gas at 80 percent SMYS would be a great economic advantage, however, the pipe manufacturing members envisioned an economic loss in the sale of pipe. The use of an 80 percent SMYS greatly improves the utilization of pipe which would reduce the tonnage of pipe purchased. The Committee finally resolved all the issues involved in design, hydrostatic testing, and control of ductile fracture and approved provisions for pipelines to operate up to 80 percent SMYS. The allowance to operate pipelines to a maximum limit in onshore Class 1 locations was published in the ASME B31.8a - 1990 Addenda to the B31.8 - 1989 Edition.

CONCLUSIONS

The code for natural gas pipelines originated as an American Standards Association code for pressure piping. Committee members felt that the MAOP should be based on a pressure test, however, the operators were using a wide variety of field test pressures. In order to establish a consistent basis, the committee decided to use 80 percent of the 90 percent mill test, which was common to all qualified steel pipe. Thus, the MAOP for rural cross country pipelines was established as 72 percent SMYS and was published in the 1935 Edition of the American Standards Association Code for Pressure Piping, ASA B31.1.

The ASA B31.1.8 - 1955 Gas Transmission and Distribution Piping Systems was the first to designate class locations based on population density. Prior to this the previous code had allowed 72 percent SMYS for cross country pipelines and 50 percent SMYS for pipelines within the incorporated limits of towns and cities. The committee commissioned a study which indicated only 5 percent of the pipelines would require lower stress levels due to population density. The original corridor was set at ½ mile with the pipeline in the center line. The corridor was later reduced to ¼ mile in the ASME B31.8 - 1982 Edition. As a result of the study four stress levels were set, based upon increasing population density, which were defined as Class 1 (72% SMYS), Class 2 (60% SMYS), Class 3 (50% SMYS), and Class 4 (40% SMYS). Also four types of construction were identified to assign stress levels for fabrications, compressor stations, highway and railroad crossings in Class 1, Class 2, Class 3, and Class 4 locations.

Beginning in the early 1950's, hydrostatic testing was developing as a major tool to prove the integrity of the pipe. Some operators realized the value of testing pipe to actual minimum yield strength after many years of research and development, and some were using the actual minimum yield strength to determine MAOP. One operator actually used the determined actual SMYS to establish MAOP's in excess of 80 percent SMYS. Based on many years of research, testing and operational experience, the ASME B31.8 Committee developed code material for establishing an 80 percent SMYS MAOP. This provision was published in ASME B31.8a - 1990 Addenda to the B31.8 - 1989 Edition.

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4. Duffy, A.R., et al, "Study of the Feasibility of Basing Natural Gas Pipeline Operating Pressure on Actual Yield as Determined by Hydrotest," A.G.A. Report L 30050, 1968.

5. Hazardous Materials Regulation Board, "Establishment of Minimum Standards," *Federal Register*, U.S. Department of Transportation, Title 49, Chapter 1, Parts 190 and 192, August 19, 1970.

APPENDIX F

ARTICLES BY F.A. HOUGH ON THE ASA CODE B31.1 SECTION 8

The following articles are reprinted with permission by Pacific Coast Gas Association, March 9, 1999.

The gas industry has approved its new safety code
By F.A. Hough, Vice President, Southern Counties Gas Co., Los Angeles
***GAS* — November, 1954**

Actions disclose intent and purpose much more than do words. The gas industry by its *actions* during the past two and one-half years has clearly demonstrated the great importance that it assigns to adequate and proper industry safety standards.

As all readers of *GAS* Magazine know, the gas industry and related industries have been spending a great deal of time, money, and effort in the development of a revised safety code covering gas transmission and distribution facilities. This project was started at the request of the American Gas Association and has been financed by that association. A substantial contribution to a related research project on pipeline pipe has been made by the major pipe manufacturing companies and the AGA. The fitting manufacturing industry, pipe fabricators, pipeline contractors, the insurance industry, and consulting engineering firms have all taken an active part in the development of the revised code. The work of developing the code has been done by an American Standards Association committee, AGA B31, Subcommittee 8, and the new code will be published as an American Standard Code by the American Society of Mechanical Engineers, which is the sponsoring society.

As this is being written, it appears that all necessary approvals of the code will soon be forthcoming and that it can be published in December 1954. Subcommittee 8 and the utility company members of the American Gas Association have approved the latest draft of the code by a very decisive vote. In view of the results of these two ballots, it is expected that formal approval by the AGA, the ASA, and the ASME will be given without delay.

This is the first comprehensive code covering the design, construction, operation, and maintenance of gas transmission and distribution facilities that the gas industry in the United States has had. This code, like all codes of its type, is intended to be a statement of what is generally considered to be good practice in the industry; consequently, many companies will undoubtedly find that most of their current practices conform to the new code. However, I expect that practically every gas transmission and distribution company will find it desirable in the light of this new code to change some of its practices and to adopt new practices which will contribute to improved public safety.

The new code has been developed with the idea in mind that it can, if necessary, be adopted by reference by government agencies having jurisdiction over gas transmission and distribution facilities. By providing a suitable and adequate standard code for this purpose, the industry hopes to avoid having to live under a multiplicity of non-standard state and federal codes, each different from the others and some perhaps ineffective or unduly burdensome. However, this has not been the primary objective of the project. The primary objective has been to make a major contribution to the improvement of public safety as it is affected by gas transmission and distribution facilities by ferreting out the causes of failures of such facilities and setting down for the guidance of the industry, procedures and methods which will tend to reduce the frequency of such failures. Compliance with the new code in good faith will accomplish just this. The benefits to be derived by the industry from this activity will be found in a reduction in accidents and failures and the very important improvements in public relations and public acceptance of our product that will come as a result.

There are compelling reasons why all companies in the industry will want to comply with this code regardless of its ultimate legal status. In my opinion the greatest benefit to the industry and to the public will come if the industry is left free to comply with the code on a voluntary basis. If this is done, operations under the code will be less cumbersome and the industry will be free to make improvements in the code as new materials become available or new information is developed. The industry through operation of its appliance testing laboratories has already demonstrated in a striking way that it can regulate itself effectively in matters affecting public safety.

I hope that the American Gas Association and the regional gas associations will continue to sponsor research having as its primary objective the improvement of the safety of its facilities, and that these associations will continue to sponsor programs and reports that will sustain a high degree of safety consciousness and an awareness of the importance of the industry's practices affecting public safety. The industry's code committee should remain an active and alert committee that will revise or supplant the code frequently as experience operating under it and as new equipment, materials and methods make revision desirable.

For those who have not seen preliminary drafts of the proposed code, a discussion of some of its important provisions is presented in the accompanying box. Many limitations and exceptions to the application of these provisions are set forth in the code but cannot be repeated here for lack of space and time.

It will be noted in the box that provision is made for retroactive application of the code.

Design, construction and testing provisions of the code which produce an improvement in safety commensurate with their cost when applied at the proper time during the design or construction of a facility would usually impose a cost out of all proportion to the benefits derived, if an attempt were made to apply the same provisions to existing installations. This is a fact generally recognized by building officials and others charged with the development of building codes and similar codes concerned with public safety.

It is expected that Subcommittee 8 will remain an active committee for the purpose of providing answers to questions raised concerning the intent of the code, and to revise the code as experience with its use and as new developments require.

The American Standards Association has a systematic procedure for handing inquiries. All requests for interpretations or suggestions for revisions should be addressed to the Secretary, ASA Committee B31, 420 Lexington Ave., New York 17, or to that committee in care of the ASME, 29 W. 39th St., New York 18. In either case the request will be routed to the proper committee or individual for preparation of a reply.

Requests for interpretations or changes in the code for clarification can usually be acted upon promptly. Requests for basic changes in the code or questions that disclose the need for basic changes require more time. When an approved reply to an inquiry involves a change in the code rules, the ruling is made public through the issuance of a case. This is published in "Mechanical Engineering" and also issued to all subscribers to the ASME Piping Code Interpretation Service. Other changes are usually handled by issuing revisions to the code once each year. Suggestions for revisions may originate within the committee itself or from anyone outside the committee. The ASME maintains a revision and interpretation service pertaining to the Code for Pressure Piping. The current annual fee is $2 and it is recommended that users of the code subscribe to this service as the most effective means of keeping up to date.

It is expected that the new code will be published in December and it can be obtained by placing orders with the ASME. The price per copy has not yet been established.

A Discussion of Some Important Provisions in the Code

1. *Qualification of materials and equipment.* All materials and equipment entering into gas transmission and distribution facilities must be qualified as to their safety for the conditions under which they are to be used. In the case of major items, such as pipe and fittings, this can be accomplished by using items that conform to approved specifications listed in the code. Items for which no standard specifications are listed in the code may be qualified by procedures set forth in the code which are simple or complicated depending upon the importance of the item from the standpoint of safety and the type of service it is to be in.

2. *Welding.* The code contains a chapter on welding, which covers preparations for welding, qualification of welding procedures and welders, and the inspection and testing of welds. Both distribution system and transmission pipeline welding are covered. The importance of proper welding procedures and adequate quality control when welding high strength pipe for high pressure service is emphasized. The importance of preheating and/or stress relieving under specified conditions is emphasized. In general the welding requirements correspond closely with those in the new Section 6 of the Pressure Piping Code, which in turn are carefully coordinated with Section 9 of the ASME Boiler and Pressure Vessel Code. API Standard 1104, "A Standard for Field Welding of Pipelines," is acceptable under the code as a field welding specification, if the options in that specification are properly specified in accordance with the code.

3. *Fabrication details.* A chapter devoted to this subject covers flanges, bolting, gaskets, fittings, valves, branch connections, and special components fabricated by welding. A greatly amplified and improved section on branch connections is given. There are also new sections on expansion and flexibility, and on supports and anchors. The importance of providing adequately for the relative movement of underground pipelines in the design of interconnections between such lines is emphasized.

4. *Pipeline design.* Pipeline design procedures prescribed in the new code are similar to the design requirements of the code that is now in effect in that design is based upon the specified minimum yield strength of the pipe rather than upon the ultimate strength, and upon nominal wall thickness rather than minimum pipe wall thickness. The maximum stress level permitted for pipelines in rural and thinly populated areas is the same in the new code as in the old, namely 72% of the specified minimum yield strength of the pipe. At this point, however, the similarity ceases. In the new code, design is based on four location classes. Classification of locations is based on the density of population along the route of the proposed pipeline. A specific method for determining this density is prescribed by the code. These four location classes encompass the entire range from remote, sparsely settled locations on one hand to big city streets on the other. A maximum design stress is prescribed for each location class, the highest being 72% of the specified minimum yield strength and the lowest being 40% of the specified minimum yield strength.

   The maximum working pressure of a pipeline is also limited to a specified percentage of the pipe mill test pressure, and this sometimes becomes the controlling factor. The code prescribes that fabricated assemblies such as mainline valve assemblies, shall be designed for a lower hoop strength than 72% in all cases.

   While the provisions of the new code relating design to location of the pipeline vary widely from the existing code, designs based on the new code come closer to conforming to the designs actually used by pipeline companies in recent years than would a design based upon a literal interpretation of existing code.

5. *Installation.* The code stresses the importance of adequate inspection during construction. It emphasizes the importance of avoiding scratches and gouges in highly stressed pipelines and prescribes that when defects are found, they shall be removed. The field repair of such defects is not permitted.

6. *Requirements for testing after construction.* In general the code requires that all transmission and distribution piping be tested after installation and before being placed in service. If the operating pressure is to exceed 100 psi, both a leak test and a test to demonstrate structural adequacy are required. If the operating pressure is to be below 100 psi, only a leak test is required.

   In rural and sparsely populated areas the test to demonstrate structural adequacy may be with gas or air to 110% of the maximum operating pressure, or with water to at least 110% of the maximum working pressure.

   In fringe areas around town and cities no gas testing is permitted. In such locations an air test to 125% of the maximum working pressure or a water test to at least 125% of the maximum working pressure is prescribed.

   In towns and cities, hydrostatic testing is prescribed in all cases where a hoop stress exceeding 30% of the specified minimum yield strength is required during the test. In such locations the minimum test pressure is 1.4 times the maximum operating pressure. Since distribution piping is usually stressed to much less than 30% of the specified minimum yield strength, hydrostatic testing of distribution mains and services is rarely required under the code.

   The code prescribes that in all cases the testing be done with due regard for the safety of employees and the public during the test. It requires that in all cases where air or gas is used as the test medium "steps shall be taken to keep persons not working on the testing operations out of the testing area during the period in which the hoop stress is first raised from 50% of the specified minimum yield strength to the maximum test stress, and thereafter until the pressure is reduced to the maximum working pressure."

7. *Cast iron pipe.* Design requirements for cast iron mains and services conform generally to the requirements of ASA A21.1, A21.3, A21.7, and A21.9.

8. *Compressor stations.* Compressor station, construction, operation and maintenance items affecting safety are covered by the code. Subjects covered include location of site, provisions for escape from fenced areas, electrical facilities, corrosion control, liquid removal ahead of compressors, fire protection, emergency shutdown facilities, engine over-speed stops, over-pressure protection devices, building ventilation, and design of high pressure gas piping.

9. *Pipe-type and bottle-type holders.* The code prescribes that all holders of these types be installed underground. It prescribes permissible stress levels depending upon the location of the facility, clearance between containers, and distances they are located from property lines.

10. *Overpressure protection.* Numerous accidents in the gas industry have demonstrated the importance of preventing the accidental overpressuring of gas transmission and distribution facilities; consequently, this subject has been given extensive treatment in the code. The extent of this treatment can be indicated by listing here the paragraph headings in the section on "Control and

Limiting of Gas Pressure." They are:

a. Basic Requirement for Protection Against Accidental Overpressuring.

b. Control and Limiting of Gas Pressure in Pipe and Bottle Type Holders, Pipelines, and All Facilities That Might at Times be Bottle Tight.

c. Maximum Allowable Operating Pressure for Pipelines or Mains.

d. Qualifying a Pipeline or Main for a New or Higher Maximum Allowable Operating Pressure.

e. Control and Limiting Gas Pressure in High-Pressure Distribution Systems.

f. Maximum Allowable Operating Pressure for High-Pressure Distribution Systems

g. Qualifying a High-Pressure Distribution System for a New and Higher Maximum Allowable Operating Pressure.

h. Control and Limiting of Gas Pressure in Low-Pressure Distribution Systems.

i. Maximum Allowable Operating Pressure for Low-Pressure Distribution Systems.

j. Conversion of Low-Pressure Distribution Systems to High-Pressure Distribution Systems.

k. Control and Limiting of the Pressure of Gas Delivered to Domestic and Small Commercial Customers from High-Pressure Distribution Systems.

l. Requirements for Design of All Pressure Relief and Pressure Limiting Installations.

m. Required Capacity of Pressure Relieving and Pressure Limiting Devices.

n. Proof of Adequate Capacity and Satisfactory Performance of Pressure Limiting and Pressure Relief Devices.

11. *Gas Services and customers' meters and regulators.* The location and type of valves required for service shutoffs are specified. Under some conditions so-called tamper-proof valves are required. The testing of services after they are installed and before they are placed in operation is prescribed. There are basic requirements concerning meter and regulator locations.

12. *Vaults.* Vaults above a specified size housing pressure regulating equipment are required by the code to be ventilated. It is also required that they be of adequate size to permit proper installation and maintenance of equipment.

13. *Operating and maintenance procedures.* The code prescribes that each operating company having gas transmission or distribution facilities within the scope of the code shall:

a. Have a plan covering operating and maintenance procedures in accordance with the purpose of this code.

b. Operate and maintain its facilities in conformance with this plan.

c. Keep records necessary to administer the plan properly.

d. Modify the plan from time to time as experience with it dictates and as exposure of the public to the facilities and changes in operating conditions require.

Some essential items to be included in the plan are listed for each type of facility, such as pipelines, distribution systems, compressor stations, bottle-type holders, and pressure limiting and pressure regulating facilities, valves, and vaults.

14. *Retroactive application.* The subcommittee's intent concerning the retroactive application of the code can be best stated by quoting from the code:

15. "It is *not* intended that this code be applied retroactively to existing installations insofar as design, fabrication, installation, established operating pressure and testing are concerned. It is intended however, that the provisions of this code shall be applicable to the operation, maintenance, and uprating of existing installations."

Part 1 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

A Background Discussion by Fred A. Hough [1]

I have accepted the invitation of the editors of *GAS* Magazine to write a series of articles on the new American Standards Association code for Gas Transmission and Distribution Piping, ASA B31.1 Section 8. This code has been developed over a period of two and a half years by an aggregation of experts that is unique in the annals of gas industry technical committees because of the caliber of the membership and the wide scope of interests represented.

Because of the limitations that are of necessity placed on the language and material entering into a code, much valuable information and discussion that went on during the development of the code is not to be found within the finished document. The editors of *GAS* Magazine have felt that a series of articles presenting some of this background material, if published during the period when the code is first made available to the industry and is first being placed in use by the industry, would help those who are faced with the task of using the code and are endeavoring to bring company practices and policies in line with the code.

These articles are intended to call attention to the code itself and to specific items in the code, and to give background material concerning the thinking of the committee and some of the facts that led the committee to its conclusions. It is hoped that they will aid those who use the code to understand it and to recognize the significance of some of its provisions. On the other hand, these articles have no official status. They are not intended to amplify or interpret the code. The wording of the code must stand by itself. If users of the code wish official interpretations or clarifications, these can be had by writing to the secretary of committee ASA B31 at 420 Lexington Ave., New York 17, or to the committee in care of the American Society of Mechanical Engineers, 29 W. 39th St., New York 18.

When, as a result of such inquiries, an official interpretation of the meaning of the code is given or revisions of the code are made, these are reported as cases and published in Mechanical Engineering and other magazines as they may desire to do so.

Those who want to be automatically notified of any such changes may subscribe (for a fee) to the ASME Revision and Interpretation Service pertaining to the Code for Pressure Piping.

This first article will be confined to a discussion of the first two major subdivisions of the code—the Foreward and the section on General Provisions and Definitions. In these two sections the history of the code is recounted, the mechanism and procedures involved in getting official interpretations and revisions is described in detail, and the scope and intent of the code is defined.

[1] Fred Hough was chairman of ASA B31, Subcommittee 8, which developed the code. Formerly vice president of Southern Counties Gas, he is now a consulting engineer with the Bechtel Corp.

The history and development of the code
***GAS* — January, 1955**

Perhaps the first and most important thing for all users of the Code for Gas Transmission and Distribution Piping to understand is the basic purpose and intent of all safety codes of the type we are considering here. All codes of this type are intended to be a statement of what is generally considered to be good practice within the subject industry, concerning design, construction, operation, and maintenance practices affecting public safety. Perhaps the true nature of such a code can be best explained by pointing out some of the things that such codes are not.

In the first place, such a code is not a law. Since it is intended to be a statement of what is generally accepted to be good practice, it is naturally written by engineers, operators, and managers, who, as a result of their experience and their knowledge of the engineering and scientific principles involved, state what they agree is good practice from the standpoint of public safety. While members of the learned and highly respected legal profession greatly assisted individual members of the committee by explaining to them the legal significance of the code, they did not say or imply that active participation on their part in the drafting of the code was either necessary or desirable. Any such participation would be apparent to a court before which the code was presented as a statement of what is generally accepted as good practice in the industry and the effectiveness and acceptance of the code as such might thereby be impaired. On the other hand, if a code is developed by a competent and truly representative committee and is accepted by an overwhelming majority of the industry, as ours has been, it then has very important legal significance as a statement of what is generally considered to be good practice within the industry, and as such cannot be safely ignored regardless of whether or not it is adopted by reference as such a statement by government agencies having jurisdiction.

Since a code is merely a statement of what is generally accepted to be good practice, it cannot and should not attempt to say who is responsible for complying with such practice in any specific case. For example: Let us assume that the code states that a pipeline, if installed in a certain type of location and under a specified set of conditions, shall be tested in a manner described in detail in the code. The code in doing this has stated what is good practice under the circumstances; however, the question as to who should make the test or who is responsible if a test is not made and a pipeline failure occurs as a result, is not a matter which the code can or should attempt to state. That is a matter of law and contractual relationships. Consequently, the code committee has very properly avoided stating who should be responsible for carrying out a prescribed practice. It simply states the practice.

Furthermore, since a code states what is generally accepted good practice, it cannot include good practices that are not generally accepted. Consequently, new practices that some may feel are far superior to old practices cannot get into a code until the industry generally has been convinced that the new practices are acceptable. Generally speaking, to be acceptable a practice must not only be sound from a technical standpoint but it must be considered necessary in the light of the industry's experience from a public safety standpoint. Because of these limitations, many superior practices, which under some conditions at least are highly desirable, are not prescribed in the code.

This brings us to a discussion of the significance of the word "minimum" in such statements as the following, which, incidentally does not appear in our code: "The standards and specifications cited herein are minimum requirements." Many public officials and others have the impression that a minimum requirement is not necessarily an adequate requirement; consequently this wording has been avoided in Section 8 and has been replaced by the statement: "The requirements of Section 8 are adequate for safety under conditions normally encountered in the gas industry. Requirements for abnormal or unusual conditions are not specifically provided for, nor are all details of engineering and construction prescribed.

It is intended that all work performed within the scope of this Section shall meet or exceed the safety standards expressed or implied herein." While this statement is longer, I believe it is better than the one involving the word "minimum," as it more clearly states the intent of the committee.

It should be emphasized here that our code was not written to be used as a specification. A specification covering for example, the construction of a pipeline, is intended to be an essential and integral part of a contract between the owner and the construction contractor. As such it spells out in detail the contractor's and the owner's duties under the contract. A specification is usually written with a specific job in mind, consequently it can be much more explicit concerning most items than the code can be. The code in many cases gives a number of options. The owner may not wish to give all of these same options to the contractor, but may wish to specify one. While one requirement in a construction contract might be that all work shall be done in compliance with the code, in most cases the owner will wish to spell out in detail which specific options available in the code are to be used, and in many cases may wish to prescribe more elaborate and expensive requirements than are prescribed by the code, because of special or unusual conditions of the job.

While talking about specifications, it would be well to discuss briefly the incorporation of standard specifications by reference in our code. Through the standardization activities carried on by the American Standards Association, the American Society for Testing Materials, the American Petroleum Institute, and others, many of the products widely used in American industry are made to conform with certain standard published specifications. Many of these specifications are incorporated by reference in our code. Sometimes people become confused as to the relationship between these specifications and the code. Perhaps the simplest general statement that can be made to clarify this matter is that a specification is intended to fully describe a material or piece of equipment and to specify the tests and tolerances to be applied to determine whether a given sample fits the description accurately. By the use of such a specification a purchaser can conveniently describe in great detail the material or equipment he wishes to order.

Our code, on the other hand, prescribes conditions of use to which items complying with standard specifications can be put. It is the responsibility of a code committee to examine each of the material and equipment specifications incorporated in the code to see to it that such specifications produce materials or equipment that are suitable for the uses for which they are to be put under the code and to see whether adequate standards of quality control are prescribed by the specifications to insure an adequate degree of public safety. While many specifications are drawn up with conditions of use in mind, this does not relieve the code committee of determining whether new uses or new conditions have arisen which make the specification inadequate.

Paragraph 804.6 of the code states: "It is not intended that this code be applied retroactively to existing installations insofar as design, fabrication, installation, established operating pressure, and testing are concerned. It is intended, however, that the provisions of this code shall be applicable to the operation, maintenance and up-rating of existing installations."

The question of the possible retroactive application of the code by government agencies is one which frequently comes up. The code committee, of course, has no way of controlling the way in which the code is used; however, it should be clearly understood that in drafting this code the committee did not intend that it should be applied retroactively, except as stated above. Obviously everyone who spends dollars to achieve safety wants to make the greatest possible improvement in safety per dollar expended. Practices regarding design and construction which give added safety are prescribed by the code because the improvement in safety is commensurate with the cost. However, in many cases, if the same practices were prescribed for existing installations, the costs involved would be very great and out of all proportion to the improvement in safety achieved. It is evident, because of this fact, that no code written with the intent that it be applied only to new installations should be applied without modification and change, retroactively to existing installations. If there is need for improving the safety of existing installations, this matter should be considered as a separate problem and the most practical and effective solution developed for that problem.

There are significant comments to be made about the definitions of terms given in the section on General Provisions and Definitions; however, these will be left for later articles covering the specific sections of the code to which the definitions apply. In the next article we will discuss Chapter I of the code on Materials and Equipment.

Part 2 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Materials and equipment: Chapter 1 of the code
***GAS* — February, 1955**

The basic requirements of the code regarding materials and equipment that become a permanent part of a gas transmission or distribution piping system is stated in paragraph B10.1, which says, "It is intended that all materials and equipment that will become a permanent part of any piping system constructed under this code shall be suitable and safe for the conditions under which they are used. All such materials and equipment shall be qualified for the conditions of the use by compliance with certain specifications, standards, and special requirements of this code, or otherwise as provided herein."

Standard specifications

Through such organizations as the American Standards Association, the American Society for Testing Materials, the American Society of Mechanical Engineers, the American Petroleum Institute, the American Welding Society, the American Waterworks Association, the Manufacturers Standardization Society of the Valve and Fitting Industry, standard specifications have been developed to which some materials and equipment entering into gas transmission and distribution systems are manufactured. These standard specifications prescribe in precise terms the chemical and physical properties and the dimensional tolerances of material or equipment manufactured under them.

In many cases they also prescribe the tests that shall be used to determine compliance with their specifications.

These standard specifications serve very useful purposes. They relieve the purchaser of the need for developing specifications of his own, a job for which he is usually not technically qualified. However, probably the most important benefit deriving from these standard specifications is the manufacturing standardization which they make possible. When standard specifications are generally used in an industry, manufacturers can design and manufacture their products to meet a few standard specifications. If no such specifications existed they would have to manufacture to many non-standard specifications, which would increase their costs and consequently their price to the purchaser.
While most specifications are developed with some specific use of the produced in mind, generally speaking the limitations on the use are not stated in a specification and it is the responsibility of the purchaser or the code-writing bodies to spell out the conditions of use under which material or equipment manufactured under a given specification is suitable.

A code committee usually cannot give carte blanc approval to a specification for use under all conditions that might be encountered in an industry. Consequently the user always has the obligation of determining whether the specifications approved by a code are actually suitable under the specific conditions under which he proposes to use the item.

Standard specifications are very important to manufacturers. Consequently, they take a very active part in their development and usually their interest is greater and more sustained than the interest of the user groups. Therefore, standard specification committees tend to be dominated by the manufacturers and the tendency is for the tolerances prescribed in a specification to be broad enough so as to reduce to a minimum the rejects which a manufacturer will have. This very often results in the tolerances in a specification being so broad that the user cannot be sure that material or equipment purchased under the specification is going to be suitable for his specific use.

Line pipe specification

Consider the API 5LX specification for line pipe, for example. This specification was developed to meet the natural gas transmission industries' need for pipe with high yield strength. Until it was recently revised, there were no chemistry limits specified for grades higher than X-42. As a result, a purchaser of pipe manufactured under 5LX-52 might obtain pipe that is readily weldable under the field conditions under which the pipe must be welded, or he might obtain pipe that was not weldable except by special procedures. Consequently, the user had to be alert to this situation and be prepared to use special welding procedures if difficulties were encountered.

Through the efforts of Subcommittee 8 and the cooperation of the API pipe specification committee and the pipe manufacturers, this defect has been partially eliminated through the inclusion of limitations on chemistry in the latest edition of API 5LX published in November, 1954.

The important point here is that a manufacturing problem was allowed to influence the specifications to the point that they no longer protected the user in one very important respect, and too, a standard specification sometimes does not specify some property which is very important to the user. For example, the standard line pipe specifications do not include any impact test requirements. This is an important property of the pipe when used at low temperatures and it is therefore necessary for the user to recognize that when conditions exist that demand good low temperature impact properties, he cannot look to the standard specifications for protection.

A specific reference to a problem of this type is contained in Section 814, which says, "Some of the materials conforming to specifications approved for use under this code may not have properties suitable for the lower portion of the temperature band covered by this code. Engineers are cautioned to give attention to the low temperature properties of the materials used for facilities to be exposed to unusually low ground temperatures or low atmospheric temperatures."

Section 811.21 of the code says, "Items which conform to standards or specifications listed in this code may be used to *appropriate applications* as prescribed and limited by this code without further qualifications." (Italics mine.)

The point which I have been trying to emphasize thus far in this discussion is that while standard specifications are very useful and helpful, it behooves a code committee and a user to examine such specifications critically to see if they really give adequate protection and cover all of the properties which are important in the use under consideration.

Some people believe that only materials and equipment conforming to standard specifications should be permitted by the code in gas transmission and distribution systems. While this might be a desirable policy at some distant future time when both code writing and specification writing have developed to a greater extent than they have now in the gas industry, Subcommittee 8 did not adopt this policy at this time for numerous reasons. Among these are: (1) Standard specifications do not exist for all materials and equipment used in gas transmission and distribution piping systems. (2) As we have pointed out above, standard specifications by themselves do not assure safety. In many cases, a modified specification designed to meet some special condition of use will be better from a safety standpoint than standard specification. (3) The use of new materials or equipment would be delayed for months or even years if the code required that they must be built to a standard specification. It sometimes takes that long to develop such a specification. Furthermore, without experience in actual use it is difficult or impossible to develop a really satisfactory standard specification. (4) If every item entering into a gas transmission or distribution system, no matter how small or unimportant from a safety standpoint, had to conform to a standard specification, a great deal of unnecessary and cumbersome red tape would be created. (5) Gas utilities and pipeline companies often find it necessary to retire from service material or equipment that is in satisfactory condition for reuse. In many cases the original specifications under which the material or equipment was manufactured are not known or are now obsolete. There are, however, uses to which such material can be put which are entirely safe and represent good engineering. Consequently the code prescribes a procedure whereby such material can be qualified for use.

The code imposes a specific obligation on the user to determine the suitability of materials and equipment that he uses. Paragraph 811.24 says in part, "Materials and equipment not covered by standards or specifications listed in this code may be qualified by the user by investigation and tests (if needed) that demonstrate that the item of material or equipment is suitable and safe for the proposed service, and provided further that the item is recommended for that service from the standpoint of safety by the manufacturer."

There are two questions involving pipe specifications which arise so frequently in connection with the design of high pressure, large diameter, gas transmission lines that they are worthy of some detailed discussion here. These two questions involve the specified minimum yield strength of the pipe and the under-thickness tolerance of the pipe. All line pipe specifications prescribe a specified minimum yield strength. The code states that the maximum operating stress in a pipeline shall not exceed a stated percentage of the specified minimum yield strength prescribed in the specifications under which the pipe is purchased from the manufacturer. In almost all cases, tests run on coupons cut from pipe at the mill disclose a higher yield strength than the specified minimum.

This raises the question as to whether the minimum yield strength observed in these tests may be used as a basis of design rather than the specified minimum yield strength. The answer is no for two reasons.

Only a sample

First, the tests represent only a sample of the pipe going into the pipeline. There is a possibility that the weakest pipe was not sampled. Second, it was recognized by the code committee that pipe manufacturers will nearly always produce pipe which has higher values than the minimum guaranteed, so as to reduce their risk of having pipe rejected for failure to comply with the specifications.
Consequently nearly all pipe now in use upon which the industry's experience is based has higher physical properties than the specified minimums under which the pipe was purchased. These facts were taken into account by the committee when establishing permissible stress levels and other conditions of use.

Likewise, pipe wall thickness measurements that indicate that all of the pipe measured has greater thickness than the minimum required by the specifications do not warrant taking advantage of this fact in the design of the pipeline. Here again there is a chance that the thinnest portions of the pipe were not measured, and furthermore, as before, the industry's experience is based on pipe which generally is thicker than the specified minimum thickness contained in the specification under which the pipe was purchased. Again, these facts were taken into consideration by the code committee in setting up stress levels and other conditions of use.

The upgrading of pipe on the basis of random sampling is always prohibited by the code.

Part 3 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Chapter 2. Welding on completed pipe
GAS — March, 1955

Chapter II of ASA B31.1 Section 8 deals with welding. The investigation by Subcommittee 8 of causes for pipeline failures disclosed that failure of field welds and factory-made girth and repair welds are a more important cause of pipeline failure than many of the subcommittee members had previously thought. In fact, failures of this type constitute the most important single type of pipeline failure resulting from causes originating in the field (as contrasted to causes originating in the pipe mill).

While this record is influenced to a considerable extent by the failure of welds made by processes not now in general use, the record also shows that there has been an important number of failures attributable to welding done since World War II by the manual arc welding process.

Welding on completed pipe

Chapter II of the code and this discussion of that chapter deal only with welding on completed pipe and do not deal with the long seam welding of pipe during manufacture.

The great use of welding in the gas transmission and distribution industry and its relative importance as a cause of failure resulted in careful attention being given to this operation by Subcommittee 8. The subcommittee had in its membership or employed as consultants a number of recognized experts on welding and related metallurgical problems. Among these are Lloyd R. Jackson, Battelle Memorial Institute; Prof. Harry Udin, Massachusetts Institute of Technology; Prof. E.C. Wright, University of Alabama; and Prof. E.R. Parker, University of California.

In addition, the pipe and fitting manufacturers made some of their top metallurgists and welding experts available to the committee. Some of the major pipeline companies gave the committee the results of their recent research on welding.

Sound conclusions

These sources of information, coupled with the experience of the subcommittee members, led, I think, to some very sound conclusions by the committee concerning the cause of current welding difficulties and their elimination.

The most important basic cause is the use of welding procedures that are not suitable when unusual conditions are encountered, such as:

1. High pipe chemistry.
2. Adverse weather conditions, such as low atmospheric temperatures or wind.
3. Making of repairs to pipe or the welding of small attachments to pipe.

Other sources of difficulty have been the use in some cases of inadequate standards of skill and quality, careless workmanship, coupled with inadequate inspection, and improper design of some joints.

To proceed now to a more detailed discussion of these causes of difficulty:

The high pipe chemistry problem is one that is usually not encountered, but it can occur unexpectedly and, by virtue of its unexpectedness, cause trouble on a pipeline construction job and in the subsequent testing of operation of a pipeline.

This problem arises from the demand of the gas industry for high strength pipe and the lack of adequate chemistry limits in the API5LX specifications.

The weldability of carbon steels used in high-strength pipe manufacture is related to their carbon equivalent $\left(C+\frac{MN}{4}\right)$. The chemistry limits of weldability found for ordinary field practices are variously stated by welding engineers to be $C+\frac{MN}{4}=.60$ or $C+\frac{MN}{4}=6.5$

The new API5LX specifications published in November 1954 contain chemistry limits for 5LX46 and 5LX52 pipe as shown in *Table1.*

TABLE 1. CHEMISTRY LIMITS

	Seamless		**Plate Pipe Cold Expanded**	
	Ladle	**Check**	**Ladle**	**Check**
Carbon, max.	.32	.35	.28	.32
Manganese, max.	1.35	1.40	1.25	1.30

Seamless pipe on the high side of the limits permitted by this specification will have a carbon equivalent of $.35+\frac{1.40}{4}=.70$.

Likewise, cold expanded pipe complying with this specification can have a carbon equivalent as high as $.32+\frac{1.30}{4}=.645$.

Border line

It can be seen, therefore, that even the new specification API5LX, which for the first time imposes chemistry limits for X46 and X52 pipe, includes pipe which is on or beyond the border line of weldability by ordinary field procedures.

In order to avoid exceeding the chemistry limits imposed by the new specifications, pipe manufacturers will, of course, aim at a carbon and manganese content considerably below the specified limits and only a small percentage of the total pipe produced will have carbon and manganese contents closely approaching the specification limits. However, the unavoidable variations in chemistry inherent in the pipe-making process will result in some pipe having chemistry at or near the high limits of the specification. In the field there is no way of differentiating this high chemistry pipe from the rest. If it is welded by some widely used procedures during adverse weather conditions a seriously defective weld can result.

Adverse weather

Consider now the effect of adverse weather conditions. Rapid cooling of a weld in high-strength pipe is objectionable. It causes under-bead cracking and lack of ductility. If welding is done in cold weather, the pipe welded will be cold and consequently the rate at which the weld and adjacent metal cools is high. Wind intensifies this effect.

The placing of a small weld on a large mass of cold pipe metal is bad because of the rate at which the large mass will conduct heat away from the weld. This is the reason why the repairing of defects in large pipe, either in the pipe plant or in the field, often leads to trouble. Even if the original defect, such as a crack, is completely removed by grinding, the repair weld is likely to crack because of the chilling effect on the weld of the surrounding mass of cold metal.

The making of small attachments to large pipe by welding is bad for the same reason.

Faulty design which does not prescribe smooth transition from one cross-section to another where pipes of different thicknesses are joined or where pipe is welded to a thick valve or fitting; or faulty design which results in stress concentration at a weld, all can lead, sometimes, to weld failure.

All of the causes of weld failure thus far discussed are actually the result of poor engineering and are not necessarily associated with unskilled or careless welding (although, of course, a poorly made weld is sometimes a contributing cause of failure).

Having in mind now the important causes of pipeline welding difficulties, what remedies are prescribed or recommended by the code?

Qualified welders

The code prescribes that all pipeline welding be done by properly qualified welders in accordance with a procedure that has been proven by tests to be capable of producing sound welds under field conditions.

If this is done intelligently and the procedure is followed in the field, most pipeline welding difficulties can be eliminated. Some companies who anticipate using their welding procedures in cold northern climates are qualifying their procedures by having test welds made in a cold room. The temperature in the cold room is held to the lowest temperature at which welding will be done in the field. Fans in the cold room are used to create realistic wind conditions. Pipe on the high side of the chemistry of the pipe specification is used. Welds made under these conditions are then subjected to the qualifying tests prescribed by the code. These may be those prescribed by:

- ASME Boiler and Pressure Vessel Code Section IX,
- ASA B31.1 Pressure Pipe Code Section 6, Chapter IV, or by
- API Pipeline Welding Specification 1104.

If alloy steel base metals are involved, either one of the first two codes above must be used.

Under-bead cracking tests, although not prescribed by any of the codes, are very useful in checking the suitability of a welding procedure for use in low ambient temperatures.

Almost all procedures designed for welding in cold weather employ the hot-pass technique. This technique consists of following the stringer bead with the second pass (hot pass) as soon as possible and before the heat picked up by the pipe in the immediate vicinity of the weld has dissipated. On 16-in pipe and larger at least two welders work simultaneously on the stringer bead and second pass so as to maintain as high a pipe temperature as possible.

The code points out the great value of preheating the base metal before welding when low metal or ambient temperatures exist. Preheat to 300°F has been found to be very effective. Preheating reduces the rate of cooling of a weld, thus reducing the hardening and cracking tendencies. It is essential even in warm weather when a small amount of welding is done on a relatively large mass of metal (as, for example, when a repair weld or small attachment is made).

The low-hydrogen electrode can be beneficially employed in welding procedures when the adverse effects of low ambient temperatures or other causes of too rapid cooling must be avoided. However, to get reliable results from this electrode, modified techniques must be used. The rod must be stored so as to prevent either moisture loss or moisture absorption.

The code prescribes joint designs that are free from notch effects and are suitable for field welding conditions.

The code classifies gas piping into two categories insofar as welding inspection, weld test, standards of acceptability, and welder qualification are concerned.

Hoop stress

One category involves piping to operate at a hoop stress greater than 20% of the specified minimum yield strength of the pipe, and the other involves piping to operate at lower hoop stresses. In the former case, the requirements of any one of the three codes listed above must be followed.

In the case of the lower stress level category, into which nearly all distribution piping falls, less exacting but adequate standards are prescribed. Compliance with the new code will require that all gas distribution companies and their contractors qualify their welding procedures and their welders. Many such companies have not done this in the past.

Part 4 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Chapter 3. Piping and Fabrication
***GAS* — April, 1955**

Chapter 3 of the 1995 edition of the ASA Code B 31.1 Section 8 Gas Transmission and Distribution Piping carries the title, "Piping System Components and Fabrication Details." The general content of this chapter and its purpose can best be indicated by quoting from the code. "The purpose of this chapter is to provide a set of standards for piping systems covering (1) specifications for and selection of all items and accessories entering into the piping system other than the pipe itself; (2) acceptable methods of making branch connections; (3) provisions to be made to care for the effects of temperature changes; (4) approved methods for support and anchorage of piping systems, both exposed and buried."

Chapter 3, (and Chapter 2 on welding discussed in our March article), was developed by a sub group under the Chairmanship of F.S.G. Williams who is manager of engineering standards for Taylor Forge and Pipe Works.*

The basic principle upon which Chapter 3 is based is stated in Paragraph 831 as follows, "All components of piping systems including valves, flanges, fittings, headers, special assemblies, etc., shall be designed to withstand operating pressure and other specified loadings with unit stresses not in excess of those permitted for comparable material in pipe in the same location and type of service."

While this is a comparatively simple statement, it is not always simple to comply with it. This Chapter does not deal with simple cylindrical pipe shapes, but with more complex shapes. Furthermore, the valves, fittings, branch connections, etc. are usually subjected to so-called secondary stresses (stresses other than those produced by internal fluid pressure) which may be of more importance than the hoop stress resulting from internal fluid pressure. In many cases, the secondary stresses cannot be accurately calculated. These factors all require that careful engineering be applied.

The studies made by Subcommittee 8 of transmission facilities failures indicated that the industry has from time to time had difficulty with valves, fittings, branch connections, etc. Much of this difficulty arose from the use of items that have been superseded by welded construction and are for the most part obsolete. However, the experience of committee members and the studies made by the committee indicate that "modern" all welded construction involving both field fabricated fittings and reinforcements, and manufactured fittings and reinforcements, have caused sufficient trouble to indicate that there is need for improvements in design, fabrication techniques, and testing.

Branch connections

To design and build a field-fabricated branch connection with a large-diameter side outlet for a pipeline to be stressed to 72% of the specified minimum yield strength of the pipe and not have stress levels at the

* The gas industry has benefited greatly from the time and effort that Mr. Williams has devoted to the development of Section 8, both by his contributions of engineering to Chapters 2 and 3 and by is assistance and guidance as chairman of the Pressure Piping Code Committee B31 in the organization and direction of Subcommittee 8. Mr. Williams was ably assisted in the development of Chapter 3 by Arthur McCuchan of Tube Turns, E. O. Dixon of Ladish, W. P. Kliment of Crane Co., L. W. Kattelle of Walworth Co., and by a number of pipeline engineers from the membership of Subcommittee 8 who have had experience in the design construction, and operation of compressor station piping and other complex piping connected with gas transmission and distribution facilities.

connection exceeding this 72% value in places is not easy, and difficulties encountered with branch connections indicate that in many cases stress levels around such connections exceed safe values. When a sufficient amount of reinforcement is provided for branch connections, the stress level in the crotch can be held down to acceptable values. However when this reinforcement is a saddle or pad, numerous tests indicate that a concentration of stress occurs at the points where tangents to the outside circumference of the pad are parallel to the axis of the header.

In these two regions the stresses resulting from the tendency of the pipe to bend around the edges of the reinforcement are directly additive to the hoop stress. Consequently, if the hoop stress in the mainline pipe is at 72% of the specified yield, a branch connection of this type will produce localized stresses in excess of the limit set by the code.

The code describes or recommends a number of things which if properly done will eliminate this branch connection difficulty. In the first place, the code requires that heavier-wall header pipe be used in those locations where branch connections are most frequently required—specifically, at compressor stations and in mainline fabricated assemblies such as those at mainline valves. In the latter case, the maximum hoop stress permissible in the mainline pipe is 60% of the specified yield strength of the header pipe, and in the case of compressor stations the maximum permissible hoop stress is 50% of the specified minimum yield strength of the header pipe. In the second place, forged tees or full encirclement type reinforcements are recommended whenever the ratio of the design hoop stress to the minimum specified yield stress in the header exceeds 50% and the diameter of the branch connection exceeds 25% of the diameter of the header.

Two types of full encirclement reinforcement are approved by the code. One is designed so that the branch connection can be welded to the reinforcement and does not have to be welded to the header pipe. The other is designed so that the branch connection must be welded into the header pipe and to the reinforcement. In this latter case, however, the welding of the reinforcement to the header pipe with a fillet weld around the header pipe at the end of the reinforcement is optional.

The problem of preventing serious stress concentrations around branch connections is reduced to some extent if ductile pipe and reinforcing materials are used and a pressure test is put on the piping assembly to a considerably higher pressure than the maximum operating pressure. Under these conditions, yielding will occur at points of important stress concentration during the pressure test and the assembly will assume a shape that tends to smooth out the stress pattern. Thereafter, a greater margin between operating stresses and stresses required to produce failure will exist in highly stressed areas than would have been the case had no yielding occurred.

All members of the committee were in general agreement that ductility is a highly desirable property for pipe in compressor stations and in other locations where complex assemblies must be used and where temperature changes vibration and other causes produce secondary stresses that might cause trouble around branch connections. However, the committee did not succeed in stating a code requirement acceptable to all members of the committee that would give effect to this objective. There is, however, little doubt that compressor station designers have assigned, and will assign in the future, considerable importance to ductility in selecting pipe for use in compressor stations, process plants, and other locations where complex assemblies are necessary.

This discussion of the stress concentrations around the branch connections has thus far dealt only with stress concentrations resulting from the intensification of the hoop stress in the pipe. This is only part of the problem and in many cases the less important part. Many branch connections are subjected to external forces. These are usually the result of relative movement between the header pipe and the equipment or pipeline to which the branch connection leads. Branch connections must be designed to take care of these external forces. The problem can be minimized by taking steps to reduce the external forces. This can be done by providing flexibility in the branch piping sufficient to take care of the relative movements involved or by anchoring the header pipe and everything to which it is connected so that little or no relative movement occurs.

Because of the restraint induced by the soil friction, a point on a long, straight buried pipe that is several hundred feet from the end of the pipe or from a bend in the pipe does not move as a result of changes in temperature of the pipe. A branch connection placed at such a point will consequently not move with changes in temperature, and therefore if the facility to which the branch connects is also firmly anchored no problems arise as a result of relative movement. However, if a branch connection is placed near the end of a straight capped buried pipe, the bearing power of the soil at the end cap will not be sufficient to prevent its longitudinal movement. Thus a movement of several inches may occur as the result of normal changes in temperature. A rigid pipe connection to a facility that does not move or might even have a tendency to move in the opposite direction, is almost certain to cause serious trouble.

The solution here, as has already been mentioned, is either to firmly anchor the pipeline and other facilities involved or to provide flexibility in the inter-connection, which will prevent overstressing of the branch connection on the header pipe. When large diameter pipelines are involved, big anchors presenting a large area to the soil are necessary. Situations of the type under discussion here arise where loop lines of limited length are interconnected to the original pipeline. They also occur sometimes at scraper traps and at mainline connections to compressor stations. The rather large fluctuations in pipeline temperature that occur at the discharge of a compressor station, particularly at those that do not aftercool the gas, sometimes cause trouble. This results from the hot pipeline on the discharge of the station expanding backward into the station and overstressing branch connections or equipment to which it is attached in the station.

It became apparent during the progress of the work of Subcommittee 8 that there is much to be learned regarding secondary stresses in pipelines. Knowledge of the conditions that produce such stresses became increasingly important as we progressed to design practices for the larger diameter pipelines. This led Subcommittee 8 to develop a plan for a secondary stress research program and to recommend the program to the pipeline research committee of the American Gas Association. As a result, an active committee of the American Gas Association is now proceeding with this valuable and much-needed research with the financial backing of that association.

Most of the experimental work is being done at Battelle Memorial Institute. So far, the experimental work has been focused on a study of stresses around reinforced branch connections under internal pressure, together with various types of external loads, i.e., forces applied to the branch and acting parallel to the axis of the header, and forces applied to the branch and acting perpendicular to the axes of both the branch and the header.

This program is an extension of work on branch connections instituted several years ago at Battelle by five pipeline companies.

The fitting manufacturers are taking an active interest in this work and have agreed to make their own related research work available to the AGA committee.

Other phases of the secondary stress problem which it is hoped the AGA committee will eventually study are:

1. Stresses resulting from backfill.

2. Stresses resulting from non-uniform bearing on the ditch bottom.

3. Longitudinal stresses in buried pipelines. In view of the fact that buried lines are fully restrained in some places, partially restrained in others, and restrained not at all in others, makes this a much more complex problem than many pipeline engineers realize. The idea that the longitudinal stress in a buried pipeline is ½ the hoop stress is wrong more times than right; and such an answer may be either too high or too low.

4. Stresses resulting from pipe being out-of-round.

Part 5 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Relating design of facilities to the requirements of the location
***GAS* — May, 1955**

Our earlier articles in this series on the 1955 edition of the American Standard Association Gas Transmission and Distribution Piping System Code (ASA B 31.1 Section 8) dealt with the qualification of materials for use in such systems, the qualification of welding procedures and welders, and the design of piping system components, such as branch connections.

We come now to Chapter IV of the code, which deals with the design, installation and testing of pipelines, distribution systems, compressor stations, and pipe-type holders, and which is the most extensive in the book. This article will be limited to a discussion of the general approach used by the committee in relating the design of gas transmission and distribution facilities to the specific locations in which they are to be installed and to a discussion of the provisions of the code regarding the design of high pressure transmission pipelines. Later articles on Chapter IV will cover the installation and testing of pipelines and pipe-type holders, the design, installation and testing of compressor stations and the design, installation and testing of distribution systems.

The two problems that warrant major consideration here are those connected with the selection of locations for natural gas transmission lines and the specification of hoop tress levels that are suitable for the locations in which the pipeline is to be placed. These two factors have a major effect on cost and they are among the many factors affecting public safety. They are, consequently, among the most important problems considered by Subcommittee 8.

The basic conclusions reached by Subcommittee 8 regarding these two problems are the same as the conclusions reached by the preceding committees that drafted the existing Gas Transmission code. The revised code, like the old code, limits the maximum operating hoop stress in a pipeline to 72% of the minimum yield strength specified in the pipe purchase contract and the new code, as well as the old code, requires that this stress level be reduced where the pipeline is located in densely populated areas. The new code differs from the old in the method prescribed to determine the locations where changes in operating hoop stress levels are necessary in the interest of public safety. In this respect, the new code reflects more closely actual current practice in the design of pipelines than does the old.
By and large, the old code permitted a maximum operating hoop stress of 72% of the specified minimum yield strength of the pipe in all locations except those inside the incorporated limits of cities and towns. Within those limits a maximum hoop stress of approximately 50% of the specified minimum yield strength of the pipe was specified. This method of designating where stress levels shall be changed has the virtue of being specific and subject to only one interpretation. However, it does not produce sensible results in many cases. In numerous metropolitan areas today there are districts outside the incorporated limits of towns and cities which are highly developed and have a population density typical of those inside the limits of many towns and cities. In other places, the boundaries of cities extend into remote mountainous areas for the purpose of protecting water rights, or for other reasons, and there is no reasonable prospect of substantial development in these remote districts. The lack of correlation between the boundaries of cities and population density has made it necessary for pipeline companies to use some criteria other than those set up by the old code for determining their design. Public officials have found fault with that code because of its method of designating where stress levels shall be changed.

The problem of relating hoop stress levels to pipeline locations and defining the limits within which any given stress level should be used proved to be so complex that a sub-group of Subcommittee 8 was appointed to study this problem in detail. This sub-group flew over the routes of a number of pipelines to study the practices followed by pipeline companies in the past. It also obtained aerial surveys of all of the major pipelines in the country. It employed a large engineering consulting firm to analyze these aerial photographs and to make a statistical study concerning population densities along the routes of these lines. The recommendations of this sub-group, with some modifications, were adopted by Subcommittee 8 and are included in the new code.

It was the recommendation of this sub-group that the population density in the general area traversed by a pipeline be used in determining the permissible stress level. The sub-group recommended that, in order to determine the population density in the general areas traversed by a pipeline, a zone ½-mile wide be laid out along the route of the proposed line with the pipeline on the center line of this zone and that the number of buildings intended for human occupancy within this zone be used as an index of population density and that this index be used in defining the areas in which each type of construction may be used. Precise instructions are given in the code for determining the population indices by means of which locations are classified for pipeline design purposes. They need not be repeated here; however, some further discussion of the thinking of the committee regarding the classification of locations may be helpful.

In the first place, it should be pointed out that the ½-mile wide zone used for determining these population indices does not indicate that the committee feels that this is the width of a zone of danger. The ½-mile width was selected because a zone of this width can readily be located on typical airplane photographs used for locating pipelines and because a zone of this width, the committee felt, gives a representative sample of the general area traversed.

It should also be pointed out that it was not the thinking of the committee that the design or operating pressure of a pipeline should be changed as soon as additional houses are added which bring the house count above limits specified for a given design. The committee had in mind, in setting the stress level limits in various locations, that population density at the time of the locating of the pipeline would be used as a criterion for design, but that the design prescribed by the code should anticipate that an increase in population density along the route of the line would occur. Consequently, the design limits are set with some provision for normal increase in population.

However, pipeline designers are cautioned to make additional provision for large increases in population density at the time they design a pipeline to be located in areas near centers of population where new subdivisions or new developments are likely to be located in the immediate area traversed by the pipeline. If, in such situations, liberal provision is not made in the design of the line for future changes in population, conditions may develop that will necessitate a relocation of the line, or a replacement with heavier pipe, or a reduction in the operating pressure.

The committee considered and rejected another method for determining pipeline design requirements along the route of the line. This method would require that the design of the pipeline be changed when it comes within a specified distance of a house or other building intended for human occupancy. The committee rejected this method because it fails to recognize some of the facts of pipeline life.

It is possible, of course, to locate a major portion of a pipeline so that at the time of construction it is more than a specified distance from any buildings intended for human habitation or to use a lower stress-level design in those sections where the specified separation distance cannot be attained at the time of construction. It is not economically feasible, however, to prevent the building of buildings closer to the pipeline than the specified distance after the pipeline has been installed. Furthermore, it is not possible to keep people on highways, and railroads that cross the right-of-way, or farmers the specified distance from the pipeline. To do this, it would be necessary for a pipeline company to acquire in fee rights-of-way several hundred feet wide and to fence these rights-of-way in order to keep people the specified distance away from the pipeline.

The obvious conclusion is that the public cannot be kept a specified distance from a pipeline and, consequently, safety can only be achieved by building into pipelines sufficient safety so that the hazards resulting from people and property being in close proximity to the pipeline are within tolerable limits. The code is based upon the premise that, if the design of the pipeline is adequate for the degree of exposure of the public to the line and the line to the public in a given area, an acceptable degree of safety will be achieved and no separation distances need be specified. It is true, of course, that in order to minimize the cost of rights-of-way and of construction and in order to avoid future trouble resulting from the growth of population centers, a pipeline company will, when locating a line, locate it in as thinly populated an area as is economically feasible. When there is a choice, a pipeline company will also stay as far away from existing buildings as is feasible.

Four types of construction are specified in the code. These are:

> Type A, with a maximum operating hoop stress of 72% of the specified minimum yield strength of the pipe,
> Type B, with a maximum hoop stress of 60%,
> Type C, with a maximum operating hoop stress of 50%, and
> Type D, with a maximum operating hoop stress of 40%.

Generally speaking, the type of construction prescribed by the code depends upon the population density in the area in which the pipeline is to be located. There are many exceptions to this general rule, however, as for example in certain areas where pipelines cross highways for railroads or are located on bridges. Again ignoring a number of important exceptions, it can be stated that the 72% of yield stress level is permitted in wastelands, deserts, mountainous areas, grazing land, and farm land, provided the population density index does not exceed the value specified in the code.

The 60% of yield stress level is prescribed for areas where the degree of development is intermediate between the sparsely settled areas just described and city conditions. Fringe areas around cities and towns fall in this class. The 50% of yield stress level construction is prescribed for areas subdivided for residential or commercial purposes where at the time of construction of the pipeline 10% or more of the lots abutting on the street or right-of-way in which the pipe is to be located are built upon. The 40% of yield stress level design is prescribed for construction in large city streets where heavy traffic, many underground structures, and multi-story buildings predominate.

Thus, we see that the new code sets up four location classes and four types of construction whereas the old code had two location classes and two types of construction. While the new code is more complex, it conforms more closely than did the old code to actual practice in the industry, and is, I believe, based on very sound principles.

While it is generally true that the code limits the maximum operating hoop stress to a stated percentage of the specified minimum yield strength of the pipe, there are many exceptions to this general rule. For example, if furnace lap-weld or furnace butt-welded pipe, or pipe manufactured to ASTM specifications A 134 or A 139 is used, a joint de-rating factor must be applied. Furthermore, the maximum operating pressure of a pipeline is limited by the code to 60% of the mill test pressure for furnace butt welded pipe or 85% of the mill test pressure for all other pipe. Generally speaking, used pipe or pipe of unknown origin cannot be used at the maximum stress levels permitted for new pipe made in accordance with approved specifications.

The maximum stress levels to which used or unidentified pipe can be used are prescribed in the code. Fabricated assemblies, such as mainline connections for separators, mainline valve assemblies, cross connections, river crossing headers, etc., installed in Class 1 locations (sparsely located) are to be designed for a maximum operating hoop stress of 60% of the specified minimum yield strength of the pipe.

Part 6 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Corrosivity of gases and soils and the prevention of over-pressuring
GAS — June, 1955

This article continues the discussion started last month on Chapter IV of ASA B31.1 Section 8—Gas Transmission and Distribution Piping.

The stress levels and design procedures for pipelines prescribed by the code are all based upon the assumption that the gas to be transported is substantially non-corrosive and either the soil in which the pipe is installed is substantially non-corrosive or suitable steps are taken to prevent corrosion. The code prescribes that, if a corrosive gas is to be transported or if suitable means of preventing corrosion in corrosive soils are not to be provided, the thickness of the pipe shall be increased to provide an allowance for corrosion. In such cases, the minimum corrosion allowance shall not be less than 0.050 in. for external corrosion and .0075 in. for internal corrosion. If both external and internal corrosion are to be expected, both allowances are to be added. No corrosion allowances are required in piping to be operated at stress levels of 20% of the specified minimum yield strength or less. However, the code states that the installation in corrosive soil of unprotected pipe with wall thicknesses as thin as the minimums permitted by the code is not recommended even for low pressure distribution systems.

Non-corrosive gas

Getting back to corrosion allowances for high pressure transmission lines, questions naturally arise as to what is a substantially non-corrosive gas and what is a substantially non-corrosive soil. In answer to the first question, the code says, "For the purpose of this code, any fuel gas of commercial grade, the water dew point of which is at all times below pipeline temperature, shall be considered to be substantially non-corrosive unless experience with it has indicated otherwise. Some fuel gases may be substantially non-corrosive even though their water dew point exceeds pipeline temperatures. Such gas shall, however, be assumed to be non-corrosive only if proven so by careful tests or experience."

Suitable protective coating

The questions as to how to determine the corrosivity of a soil, or what is a suitable protective coating to prevent external corrosion in a given situation, are questions upon which the code committee was unable to agree. Although some types of pipe coatings are very generally used and have proven to be quite effective, very few standard specifications for either the components of protective coatings or for the design and application of a coating have been developed by recognized and authoritative specification writing bodies. Without these, the code committee found that it could not prescribe, recommend, or even mention specific coatings without running the risk of placing other coatings that might be equally good at a serious disadvantage.

The use of cathodic protection, or the possibility of its use, further complicates the code-writing problem. A protective coating that might be quite inadequate without cathodic protection might be sufficient with cathodic protection, providing the cathodic protection is applied skillfully and with continuing qualified supervision. Consequently, the code committee has had to limit itself to requiring that, if stress levels approaching the maximum permitted by the code are used, corrosion must be held to very minor proportions. The methods by which this is accomplished are left to the owner.

Accidental over-pressuring

The accidental over-pressuring of gas transmission or distribution facilities has led, in the past, to some serious accidents. While most accidents from this cause have occurred in distribution systems and most of the material in the code, on pressure control and pressure limiting, deals with the problems encountered in distribution systems, the code does set up some very specific requirements regarding the limiting of pressure in transmission lines. The basic requirement for protection against accidental over-pressuring is:

"Every pipeline, main, distribution system, customer's meter, and connected facilities, compressor station, pipe-type holder, bottle-type holder, container fabricated from pipe and fittings, and all special equipment, if connected to a compressor or to a gas source where the failure of pressure control or other causes might result in a pressure which exceeds the maximum allowable operating pressure of the facility, as prescribed by this code, shall be equipped with suitable pressure relieving or pressure limiting devices in accordance with the provisions of this code."

In prescribing types of devices that are suitable for preventing accidental over-pressuring, the code differentiates between the type of device required for the protection of facilities that might be bottle tight and the type of device required for the protection of facilities from which some gas is always issuing. Both must be protected. Bottle-tight facilities might include a pipeline, or a section of a pipeline between valves, in which there are no leaks or only small leaks and to which a continuous load is not connected. Another example of a bottle-type facility would be a pipe-type holder that can be shut off at times so that it is not supplying any load. Suitable types of protective devices to prevent over-pressuring of bottle-tight facilities are stated by the code to be:

a. Spring-loaded relief valves of types approved for unfired pressure vessels by the ASME, or

b. Pilot-loaded back pressure regulators used as relief valves and so designed that failure of the pilot system or control line will cause the regulator to open.

Automatic devices that shut off the supply of gas to a facility when the gas pressure reaches the set maximum can be used if some gas is always issuing from the protected facility. In such cases, leakage through the protective device while it is in the closed position cannot overpressure the protected facility.

Pressure control

The control and limiting of pressure in low- and high-pressure gas distribution systems is a more complex problem from the code-writing standpoint than that presented by transmission lines. The code recognizes that if a pipeline or distribution system is operated for a long period of years at a pressure well below the design maximum pressure and substantial corrosion has occurred during this period, there is a hazard involved in some cases in raising the operating pressure above previous maximum operating levels. Consequently, it is frequently the operating pressure history of a pipeline, main, or distribution system, rather than design pressure, that determines the pressure at which over-pressure protective devices should be set to act. In such cases, the maximum safe pressure is left to the judgment of the operating company. The only code requirements being that the operating company, having decided the maximum pressure it considers safe, shall install over-pressure protective devices to prevent accidentally exceeding that safe pressure.

The code prescribes safe procedures whereby the maximum allowable operating pressure of a pipeline or distribution system can be raised to a new maximum in those cases where past practices and physical condition rather than design, determine the maximum allowable working pressure.

The code also prescribes safety precautions to be taken when a low-pressure distribution system is converted to a high-pressure system.

The accidental over-pressuring of low-pressure distribution systems has caused some of the most serious accidents in the gas industry. Consequently, the code committee gave special attention to this problem.

In this case, of course, the major hazard comes from the over-gassing of appliances and the rupture of tin meters. The code prescribes that the pressure on low-pressure distribution systems shall not exceed either: "a., A pressure which would cause the unsafe operation of any connected and properly adjusted low pressure gas burning equipment or, b., A pressure of 2 psig." Either relief valves or shutoff devices (which interrupt the flow of gas to a system when the pressure on the system exceeds a specified amount) are acceptable means of preventing over-pressure.

Detailed analysis

The code, or course, does not attempt to spell out the detailed engineering analysis that is often required to verify that a low-pressure distribution system is adequately protected from accidental over-pressuring. Large distribution systems are usually supplied with gas from a number of pressure-regulating stations. It is sometimes assumed that if one regulator feeding the system sticks in an open position this will merely result in raising the pressure on the distribution system to the point where other regulators shut off and the load on the system will then absorb the excessive flow through the stuck regulator, and that the highest pressure attained on the system will be safe. While this may sometimes be true, the validity of such an assumption should be carefully tested in all cases by comparing the delivery capacity to the stuck regulator with the capacity of the low-pressure system to carry gas away from the stuck regulator. Usually when such a study is made, it becomes apparent that a zone of high pressure would build up around the stuck regulator and in that zone the pressure would be high enough to exceed the limit set by the code. It is also necessary, of course, to consider the possibility that valves in lines that interconnect high and low-pressure systems might be opened by mistake and the capacity of the low-pressure system to carry gas away from the valve is inadequate to prevent the development of a high-pressure zone in the vicinity of the valve.

Varied situations

The different types of accidents or situations that have resulted in the accidental over-pressuring of a low pressure system have been so varied in the past that considerable study and care is necessary in each system to make sure that low pressure systems are adequately protected. One very important precaution that is stipulated by the code is that protective devices must be designed and located where an accident which causes the malfunctioning of a pressure regulator, will not also make the protective device inoperative.

The code also covers in some detail precautions that should be taken to prevent the accidental over-pressuring of meters and customers' facilities that are supplied from high pressure gas distribution systems. Certain specific requirements for house-type regulators are stated. In those cases where customers are supplied from distribution systems or pipelines operating in excess of 60 psig, it is necessary to install a protective device that will prevent overpressuring of the customers' facilities in case the house-type regulator fails to shut off. Types of devices that the code committee considers suitable for this purpose are monitoring regulators, relief valves, or automatic shutoff devices.

Part 7 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Construction and testing methods
Chapter 4 stresses good specifications, close inspection
***GAS* — July, 1955**

The May and June installments in this series on the new code covered design practice as set forth in Chapter 4. Before dispensing with that chapter, let us consider the provisions regarding the construction and testing of pipelines and mains (Sections 841.2, 841.3, and 841.4).

The first requirement of the code pertaining to construction is that written specifications shall be provided for all construction of pipelines and mains. While one provision of such specifications could be that the work shall be done in accordance with Section 8 of the Pressure Piping Code, the code itself is not intended to serve as a set of specifications In many cases, the code prescribes acceptable alternate practices. Specifications should designate the particular practice the owner wishes to use. The code does not include many things that should be spelled out in specifications that are to be part of an agreement between the owner and the contractor. Usually, it is also desirable that such items be spelled out in specifications that are to be used by the owner's own crews. The code does not imply, of course, that a separate set of specifications be written for each job. Often, standard specifications with additions or insertions to fit specific job requirements can be used.

Owners who wish to keep their records so that they provide good evidence that work has been done in accordance with the code can either file in the job file a copy of the specifications under which the job was built or can make reference there to the standard specifications that were used.

The code recommends that the construction specifications used shall cover all phases of the work and shall be in sufficient detail to cover the requirements of the code. The development of a good set of specifications, with follow-up and inspection to assure those in responsible charge of the work that the specifications are being complied with, is, of course, widely recognized as a necessary management procedure to assure sound construction and safety, regardless of whether the work is done by outside contractors or company crews.

A study of the records of past pipeline failures leads to the conclusion that many failures are the result of inadequate inspection during construction.

Our past discussions of pipe specifications and the inspection of pipe at the pipe mill emphasized the great importance of eliminating notches and scratches. It can probably be safely said that most failures of pipelines that have involved the actual bursting of the pipe at pressures below that required to stress the pipe to its specified minimum tensile strength start in a notch or groove or crack. These may be defects in longitudinal or round seam welds or they may be defects in the plate. Such defects produce triaxial stresses in the plate in the immediate vicinity of the notch and cause the plate to fail in a brittle manner. Such defects are especially serious at low temperatures and in the less ductile or notch-sensitive steels.

Cold working tends to produce notch sensitivity; consequently, if the groove or notch is caused by a blunt instrument, which also dents or deforms the steel and thus in effect cold works the steel in the immediate vicinity of the notch, an especially dangerous defect is the result. If a bulldozer blade or tractor track notches a pipe it usually also cold works the plate in the vicinity of the notch and, if so, pipeline failures of the brittle type sometimes result.

It is evident from this discussion, I think, that one of the major objectives of an inspection organization on a pipeline job is to see to it that the pipeline gets into the ground and is safely covered up without having any scratches or notches inflicted during the construction period, and that no pipe goes into the pipeline carrying such defects as a result of mishandling either in the pipe mill or during transportation. Even after a pipeline is covered by backfill it is sometimes damaged by construction equipment sinking through wet backfill and gouging the pipe.

Procedures are prescribed in the code for eliminating notches and grooves when they are found in pipe in the field. Such defects can be removed by grinding, providing the resulting wall thickness is not less than the minimum prescribed by the code for the conditions of usage. When deeper grinding would be required the damaged portion of pipe must be cut out of the line and a new cylindrical section installed in its place. Any welding or patching of gouges and grooves is prohibited.

Dents that are more than ¼-in. deep must be removed by cutting out a section of pipe and replacing it with a new cylindrical section.

Sections of pipe containing arc burns must be cut out and replaced with a new cylindrical section, unless the metallurgical notch caused by the arc burn can be completely removed by grinding without reducing the pipe wall thickness below the minimum specified.

The amount of inspection required on a pipeline job, and the number of inspectors necessary to do an adequate inspection job, are questions that are not answered by the code because, of course, general answers are not possible. The former depends upon the know-how and reliability of the organization doing the construction work and upon the integrity of the individuals involved. The number of inspectors on a big inch pipeline spread usually varies from two to ten. The smaller figure is probably never adequate and even the larger figure may be inadequate at times.

In addition to detecting notches and scratches and similar defects, the field inspection organization is concerned with other factors that affect the safety of the pipeline, such as welding inspection, coating inspection, and the inspection of bending operations. Lowering-in and backfilling also require adequate inspection. The code does not attempt to spell out in detail just what inspection operations are necessary but does give some suggestions that the committee thought would be helpful as indicators of the intensity and quality of the inspection that the committee has in mind.

The code devotes considerable attention to pipe bends. Here, again, excessive cold working of the pipe is undesirable. Long-radius cold bends made in the field under properly controlled conditions are considered to be satisfactory form this standpoint. However, bends that deform the pipe from its cylindrical shape or cause excessive localized cold working by buckling or wrinkling are not acceptable. Cold wrinkle bends are in the words of the code, "permitted but not preferred on systems operating at 40% or more of the specified minimum yield strength of the pipe." Cold wrinkle bends, of course, cause a great deal more cold working of the metal at the wrinkle than occurs at any point in a long-radius smooth bend. The code cautions against wrinkle bends that have sharp curved surfaces or wrinkles that are placed on the pipe across the longitudinal seam. Such wrinkles are prolific sources of trouble.

Mitered bends are not approved for pipelines operating at 40% or more of the specified minimum yield strength of the pipe. However, mitered deflections up to 3 degrees, even in such high pressure pipe, are permitted.

Larger mitered angles are permitted for pipelines operating at lower pressures. A 90° miter is permissible in systems operating at 10% of the specified minimum yield strength or less. The chief objection to small angle miters made in the field is the difficulty of getting a good match-up that will permit making a weld comparable in quality to the other welds in the pipeline.

The code discusses in some detail precautions necessary to avoid explosions of gas-air mixtures or uncontrolled fires during construction operations. In general, elaborate purging procedures, such as those described in the American Gas Association Purging Manual, are not required. It does point out certain specific cases, however, where such purging procedures are necessary.

The testing of gas transmission and distribution piping, after construction is completed but before the pipe is placed in operation, was probably given more attention by the committee than any other subject. The test requirements finally adopted by the committee represented a considerable departure from the testing provisions of old Section 8. That section stated that gas transmission lines must be capable of withstanding a test pressure 50 psi higher than the maximum pressure at which the line is to be operated. This was interpreted by many companies as not requiring a field test. Consequently, it was quite general practice in the gas industry to place high pressure pipelines in operation without prior testing to prove strength.

The committee early adopted the policy that all facilities must be tested before they are placed in operation. From the standpoint of testing requirements, the code divides piping into three categories: The highest pressure category piping that operates above 30% of the specified minimum yield strength of the pipe; the intermediate pressure category, pipe that operates at less than 30% of the specified minimum yield strength of the pipe, but at more than 100 psi; and the lowest pressure category, piping that operates at less than 100 psi.

The code requires that piping falling in all three categories must be tested for leakage before placing in operation. All piping in the intermediate pressure category, except piping in location Class 1, must be tested to prove strength.

The use of gas as a test medium for high pressure pipelines is greatly restricted in the new code, insofar as tests to prove strength are concerned. Gas can be used for this purpose only in pipelines located in location Class 1, which is the least populated of the four location classes into which all gas piping locations are divided in the code. The use of gas in location Class 1 is further restricted by paragraph 841.5 of the code, which states, "All testing of pipelines and mains after construction shall be done with due regard for the safety of employees and the public during the test. When air or gas is used, suitable steps shall be taken to keep persons not working on the testing operations out of the testing areas during the period in which the hoop stress is first raised from 50% of the specified minimum yield strength to the maximum test stress, and until the pressure is reduced to the maximum operating pressure."

Since a pipeline designed to operate at the maximum pressure permissible by the code in location Class 1 would normally be tested to 79.2% of the minimum yield strength if gas is used, this paragraph of the code requires that if the testing is done with gas, the public shall be removed from the test area to a safe location for a period of perhaps several hours. If the public cannot be kept at a safe distance from the pipeline during the test, water must be used as the test medium. Pipelines in location Class 2 (fringe areas around cities and towns and the more densely populated rural areas) can be tested under the code with air or water. High pressure pipelines in towns and cities must be tested with water.

The code requires a minimum test pressure that shall be used to prove the strength of pipelines and mains in all four location classes. It also prescribes the maximum test pressure that may be used if air or gas is used as the test medium. The committee felt that the setting for maximum test pressure is necessary to avoid excessive hazards of life and property during the test. No maximum test pressure is prescribed if water is used as the test medium.

The practice of companies using water for testing varies a great deal. Some use as the test pressure the minimum prescribed by the code; others use pressures high enough to cause some actual yielding of the weakest pipe in the section under test.

The strength test provisions of the new code are quite lengthy and include special requirements to meet special conditions that are sometimes encountered during the testing of pipelines and mains. For example, requirements for hydrostatic testing are modified in situations where water of unsatisfactory quality is not available in sufficient quantities or in cases where testing must be done during period when the ground temperature is below 32°F, or in situations where there is danger that the ground temperature might drop to32° or less during the test. The code also requires that, "The operating company shall maintain in its file for the useful life of each pipeline and main records showing the type of fluid used for test and test pressure."

In addition to the tests required to prove strength, all transmission lines and mains must be leak-tested before they are placed in operation.

Part 8 in a Series
The New Gas Transmission and Distribution Piping Code (ASA-B31-Section 8)

Code's outline is pattern for top-managed maintenance plan
***GAS* — September, 1955**

In this eighth and final article in our series on the new ASA Gas Transmission and Distribution Facility Code, the section of Chapter 4 on pipe-type holders and Chapter 5, on operating and maintenance procedures for gas transmission and distribution facilities will be discussed.

The code defines and provides for two types of holders, which, because of their design and the materials used in their construction, are closely related to pipelines. These are defined in the code as follows:

"1. A pipe-type holder is any pipe container or group of interconnected pipe containers installed at one location and used for the sole purpose of storing gas. A pipe container is a gas-tight structure assembled in a shop or in the field from pipe and end enclosures. 2. A bottle-type holder is any bottle or group of interconnected bottles installed in one location and used for the sole purpose of storing gas. Bottle, as used in this code, is a gas-tight structure completely fabricated from pipe with integral drawn, forged or spun-end encloses, and fabricated and tested in the manufacturer's plant."

Probably the most important code matter relating to holders of this type is the question as to whether they should be designed and constructed in accordance with one of the pressure vessel codes, or in accordance with the gas pipeline code. It was concluded by Subcommittee 8 that the design, construction, and testing should be in accordance with applicable provisions of the pipeline code rather than in accordance with the pressure vessel codes.

The basic reasons for this decision are:

1. If holders of this type are installed underground as required by Section 8, then all conditions of use are exactly comparable to the conditions of use of a pipeline installed in a comparable location. Consequently, the pipeline code fits more closely the conditions encountered in the construction and operation of these holders than does the pressure vessel code.

2. There are some important differences between the conditions assumed when a pressure vessel is designed and the conditions that can be assumed when a pipe- or bottle-type holder is designed. (a) Since the pipe- and bottle-type holders are installed underground they are less subject to fire and damage from falling objects. (b) When such a holder is designed, its exact location is known; consequently, the design can be made to fit the degree to which the public is exposed to holder hazards and the degree to which the holder is exposed to damage resulting from activities of the public. On the other hand, it is necessary to assume in the drafting of the pressure vessel codes that a pressure vessel designed under the code might be installed where its failure would result in injury to many people and that it will be installed where there is considerable possibility of fire damage.

Sections 8 of ASA B31.1 contains a section (844) devoted entirely to pipe-type and bottle-type holders. The principal requirements of this section are:

1. The holders of this type must be installed underground.

2. If they are installed in streets or on private right-of-way where the owner does not have exclusive use and control of the land upon which the holder is located, the holders must be built in all respects in

accordance with the code provisions applicable to pipelines to operate under the same pressures and in the same locations. If pipe-type or bottle-type holders are to be installed on land under the exclusive use and control of the owner, and this land is fenced, then some economies can be effected in the design of the holders under certain conditions specified in the code.

Since by definition bottle-type holders are manufactured and tested in the manufacturer's plant, the code permits the use of a steel for bottle-type holders that would not be permitted for pipe-type holders or for pipelines. This steel is a high strength steel which must be welded under carefully controlled conditions and heat treated after welding. The use of bottles made of this steel is permissible, providing all welding is done in the manufacturer's plant, and field welding on holders of this type is prohibited.

Both bottle-type and pipe-type holders are classified in the code as facilities that may, at times, be bottle tight (that is, entirely free from leakage). Consequently, devices to prevent the accidental overpressuring of the holders must conform to the code requirements for pressure-relief devices for bottle-type structures.

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Now let us proceed to a discussion of Chapter 5 of the code, which deals with operating and maintenance procedures. The question as to whether the code should contain any provisions concerning operating and maintenance procedures was one that received considerable attention. It was observed by Subcommittee 8 that all of the state codes that have been set up thus far, covering gas transmission and distribution facilities, contain requirements pertaining to operating and maintenance. Subcommittee 8 concluded, therefore, that if such provisions were not put into Section 8, the code would be considered incomplete by state and other government agencies, and such agencies would probably, in many cases, consider it necessary to supplement our code with provisions for operation and maintenance. The committee concluded, therefore, that it would be desirable for it to develop such provisions and include them in the code.

The committee quickly realized that it would be impractical to include in a national code detailed requirements concerning the operation and maintenance of gas transmission and distribution facilities. This is because of the great difference in the present condition of various systems, difference in the materials used in their construction, and different operating conditions. It is obviously possible, however, for each operating company to set up a maintenance program and operating procedures that will be well suited to its particular conditions. The basic requirement of the new code regarding operating and maintenance is perhaps unique insofar as code writing is concerned, but is nevertheless a very practical type of code provision.

The basic requirement as stated by the code is, "Each operating company having gas transmission or distribution facilities within the scope of this code shall: a. Have a plan covering operating and maintenance procedures in accordance with the purpose of this code. b. Operate and maintain its facilities in conformance with this plan. c. Keep records necessary to administer the plan properly. d. Modify the plan from time to time as experience with it dictates and as exposure of the public to the facilities and changes in operating conditions require."

The code goes on to list the type of items that should be included in a maintenance program. However, for the most part these are merely suggestions included for the purpose of developing a picture as to the magnitude and thoroughness of the maintenance program that would be considered by the committee to be adequate. A well worked-out maintenance program and a systematic statement in writing of the program is not only necessary to comply with the code, but it is necessary as a management control device in any company, particularly large companies operating over a wide geographical area. A program that systematizes maintenance work and gives management adequate control over it and that has been developed by the operating company in good faith with the intent of adequately providing for public safety as well as for other objectives that the company wishes to achieve, will put the company in compliance with the code, and will provide for a degree of maintenance that will go far toward eliminating any tendency on the part of government officials to try to spell out in detail the amount and extent of maintenance work that a company should do.

Some of the items that should be in the maintenance program, the code says, are:

For Pipelines

a. A patrolling program.

b. Periodic inspections and tests to determine if provisions made for controlling external corrosion are adequate.
c. Period inspections or tests to determine the extent of internal corrosion if there is evidence that such is occurring.
d. Corrosion control records, including cathodic protection operating data, records of surveys to determine the effectiveness of cathodic protection, and records of leaks found and leaks repaired.

For Distribution Systems

a. Periodic patrolling of mains where special hazards exist.

b. Systematic leakage surveys, the type and frequency to depend upon local conditions.

c. Procedures that will insure the proper disconnecting and sealing of services for which there is no further planned use.

For Compressor Stations

a. Approved starting, operating, and shutdown procedures that provide for safety.

b. Periodic inspection and testing of relief valves and other automatic safety devices.

c. Inspection for corrosion.

d. Approved procedures for isolating sections of pipe or equipment and purging to prevent explosions or injury during repair or construction operations in an operating station.

For Pressure-Limiting and Pressure-Regulating Stations

a. Periodic inspection and tests to determine that equipment is in good mechanical condition and adequate and set to function at the desired pressure.

For Valves

a. Valves that might be needed in an emergency should be periodically inspected and partially opened or closed to see that they are in good mechanical condition.

For Vaults

a. Period inspection and tests to see that they are adequately ventilated.

At this point I may be wandering to some extent from the subject assigned me, but I would nevertheless like to point out that compliance with a safety code is only one and possibly one of the least important benefits that a company can derive from the time and money spent to develop and set down on paper an orderly and effective maintenance program.

Such a program should not only contain step-by-step procedures for performing the operations involved and the frequency with which such operations should be performed, but it should also spell out such things as:

1. Who is responsible for the overall program.

2. Who is responsible for the proper performance of each part.

3. The records necessary to guide the progress of the program.

4. The records and reports necessary to make it possible for management to make decisions management should make.

5. Statements of policy and procedures needed so that designated supervisors can make important decisions such as when should a main be replaced rather than repaired, in the manner desired by the management.

6. Follow-up provisions to make sure that instructions are understood and are being followed by those who execute them.

Such a program can be a very effective tool of management and can

1. Make possible the accurate control of the total amount of maintenance expenditures.

2. Make sure that first things are done first.

3. Make sure that the program is economically sound.

4. Make sure that maximum benefit is obtained per dollar spent.

5. Provide statistics that indicate whether the scale of the program is keeping the overall condition of the system the same or is gradually improving it or gradually allowing it to deteriorate.

6. Give comparative cost figures to indicate the relative efficiency of various operating divisions or crews.

The code of course is not concerned with matters of this type. My point is that a basic requirement of the code can be expanded into a program that constitutes complete compliance with the code and, at the same time, puts under management control an important operation which is in many companies actually wasteful and over which management in reality has no effective control in many cases. Or conversely, a company that has taken the steps necessary to put its maintenance work under the management control that it should have, has probably by virtue of this fact already done everything that is necessary to comply with the maintenance provisions of the code.